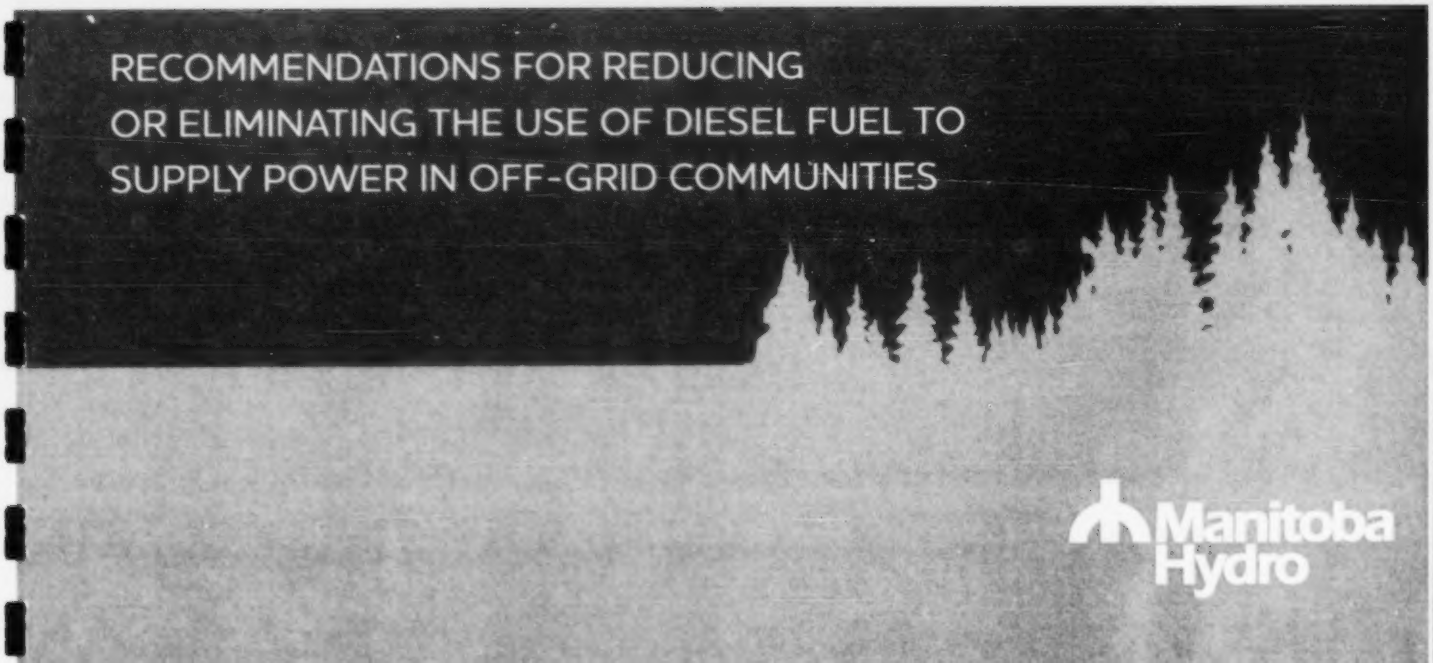
REPORT ON:

RECOMMENDATIONS FOR REDUCING OR ELIMINATING THE USE OF DIESEL FUEL TO SUPPLY POWER IN OFF-GRID COMMUNITIES



Manitoba Hydro

Table of Contents

Executive Summary i
Introduction 1
Background 2
  History 2
  Communities 2
  Load and Emissions 3
  Reliability 4
  Manitoba Hydro Electricity Rate Regulation 4
  Diesel Zone Rates 4
Supply Options 5
  General 5
  Wind 5
  Small Hydro 7
  Transmission Line 8
  Other Generation Technologies 9
  Supply Side Enhancements 11
  Demand Side Management 12
INAC and Umbrella Organizations 13
Potential Funding 13
Recommendations 14

Appendix 1 - Electricity Rates

Appendix 2 - Generating Resource Screening Studies

Appendix 3 - Community Meeting Minutes

Appendix 4 - INAC Communications

Appendix 5 - Biodiesel Price Forecast and Pilot Project Update

Executive Summary

As reliability and maintainability is of the utmost concern in these remote locations, there are only a few options that could be considered for reducing or eliminating the use of diesel for generating electricity.

The only option that eliminates the requirement for continued operation of the diesel generating station is the 66kV line option. This option provides for 200A service in all communities and from the initial discussions with the communities this is their preferred supply option. The capital cost of providing a 66kV line to all four communities is in the order of $225 million and with an accelerated schedule could be installed over three winter construction seasons. To be in service by the end of 2012, a project to connect the communities to the Manitoba grid would have to be initiated in the summer of 2009.

Opportunities exist to reduce the use of diesel generation for generating electricity, a number of which Manitoba Hydro is already undertaking. These include efficiency improvements in the generation facilities, investigation into the use of biodiesel and inclusion of these communities in Power Smart programming. As these opportunities are either in their initial stages or have yet to be initiated, it is uncertain whether they could be fully implemented by the end of 2012.

Small scale wind generation has the potential to offset up to 20% of the diesel generation, and approximately 1600 tonnes of GHG emissions, with a capital cost in the range of $21 to $40 million. The wind/diesel systems would take 1 to 2 years to install, and could be in service by the end of 2012.

A small hydro generating station to provide 60 Amp service (i.e. no electric heat) could be designed, licensed and constructed to serve the communities of Brochet and Lac Brochet in approximately 7 to 8 years with capital costs in the range of $34 to $63 million. This small hydro option requires that one of the diesel generating stations remain available to support generation under low flow conditions. The facility has the potential to offset diesel generation and resultant GHG emissions in the order of 99% under average flow conditions.

A small hydro generating station to provide 200 Amp service could be designed, licensed and constructed to serve the communities of Brochet and Lac Brochet in approximately 7 to 8 years with capital costs in the range of $36 to $68 million. This option includes the same small hydro generating station as the 60 Amp service option, but requires that both of the diesel generating stations remain available to support generation under low flow and average flow conditions. The increase in expected diesel generation is due to the increased demand expected as customers convert to electric space heating. The facility has the potential to offset diesel generation and resultant GHG emissions in the order of 81% under average flow conditions. Even with an accelerated schedule, completing either small hydro option by the end of 2012 is unlikely.

The diesel generators in these communities are very reliable with a generator availability of 99.6% over the last two years. None of the alternative supply options will result in improved reliability.

Introduction

On June 12, 2008, The Climate Change and Emissions Reductions Act (the "Act") became law in Manitoba. The purpose of the Act "is to address climate change, to encourage and assist Manitobans in reducing emissions, to set targets for reducing emissions and to promote sustainable economic development and energy security". The Act directs Manitoba Hydro to prepare a report regarding the reduction of the use of diesel fuel in off-grid communities:

> " **The Climate Change and Emissions Reductions Act**
>
> **Off-grid communities**
>
> 17(1) No later than one year after this Act comes into force or any further period that the minister may permit, Manitoba Hydro must provide the minister with a report containing recommendations for reducing or eliminating the use of petroleum-based diesel fuel to supply power in the following communities by 2012:
>
> (a) the First Nations communities of Brochet, Lac Brochet, Shamattawa and Tadoule Lake;
>
> (b) the community of Brochet.
>
> **Consultations required**
>
> 17(2) In preparing the report, Manitoba Hydro must
>
> (a) consult with the band councils of the First Nations mentioned in clause (1)(a) and the council of the community of Brochet;
>
> (b) seek input from the relevant federal authorities; and
>
> (c) determine the costs, and the potential sources of funds, necessary to implement the recommendations.
>
> **Tabling of report**
>
> 17(3) The minister must table a copy of the report before the Legislative Assembly within 15 days after receiving it if the Assembly is sitting or, if it is not, within 15 days after the beginning of the next sitting. "

This report is submitted in accordance with Section 17 of the Climate Change and Emissions Reductions Act.

Background

History

Manitoba Hydro's relationship with the diesel communities can be traced back to the late 1950s and early 1960s when the Government of Canada (Canada) approached Manitoba Hydro and requested that Manitoba Hydro assist them in providing electricity to First Nations in Northern Manitoba. Manitoba Hydro and Canada entered into agreements whereby Manitoba Hydro was obligated to provide service (construct, operate, maintain and in some cases take over diesel stations) and Canada was obliged to pay a substantial portion of the costs. During the 1970's Manitoba Hydro was contracted to provide electricity to 27 of these communities. Subsequently all but four have been connected to the grid. As per Manitoba Hydro's policy the grid connections were substantially paid for by the customer - in most of these cases - Canada.

Originally customers in the off-grid communities were restricted to 15 Amp service in order to control the cost of diesel service. In the early 1990's facilities in the remaining four communities not served by grid connection were upgraded to support 60 Amp service. 60 Amp service does not permit the use of electricity for space heat.

Communities

The four remaining off-grid communities are located in remote areas in northern Manitoba as shown in Figure 1. These communities are accessible by air year round and winter roads for about six to eight weeks each winter.

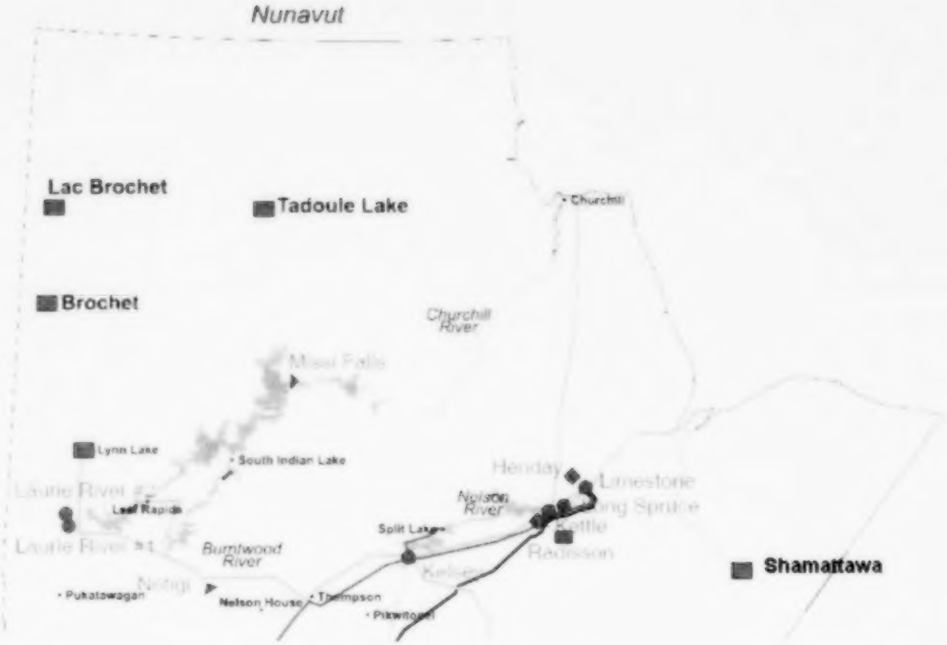


Figure 1: Location of Off-Grid Communities

Tadoule Lake is located approximately 250km NNE of Lynn Lake. As of February 2009, Manitoba Hydro served a total of 155 customers in Tadoule Lake of which 114 were residential. The total average annual energy use is 2200 MWh.

Lac Brochet is approximately 200km NNW of Lynn Lake. As of February 2009, Manitoba Hydro served a total of 189 customers there of which 137 were residential. The total average annual energy use is 3300 MWh.

Brochet is located approximately 125km NNW of Lynn Lake. As of February 2009, Manitoba Hydro served 164 customers in Brochet of which 121 were residential. The total average annual energy use is 2800 MWh.

Shamattawa is approximately 160 km East of Gillam. As of February 2009, Manitoba Hydro served 215 customers in Shamattawa of which 173 were residential. Shamattawa's average annual energy use is about 4300 MWh.

Load and Emissions

In total Manitoba Hydro provides service in these communities to a total of 723 customers of which 545 are residential. The peak demand is about 2.6MW and the average annual energy use is about 12,600 MWh. This represents about 0.05% of the total Manitoba load.

Approximately 8,000 tonnes of green house gas (GHG) emission are emitted annually as a result of the diesel generation.

Load growth in these communities is primarily as a result of increased housing and infrastructure construction. Current projections for annual load growth range between 2 and 4%, assuming no change in supply.

Should a 200Amp supply be implemented in these communities it is expected that there will be an initial significant increase in load as residential customers convert from fuel oil to electric heating. Depending on the supply source further local and/or global emissions reductions could occur, however that is beyond the scope of this report.

Reliability

Because of their remote locations and the related climate, dependable reliable electricity generation is imperative. The diesel generators in these communities have proven very reliable and are generally accepted in the industry as the most effective and reliable form of electricity generation in remote locations. Generator availability was 99.6% over the last two years, continuing to provide an extremely high reliability of supply.

Manitoba Hydro Electricity Rate Regulation

The rates charged by Manitoba Hydro are regulated by the Public Utilities Board of Manitoba on a cost recovery basis. Generally, rates are set such that the costs incurred to serve a group or groups of customers are recouped by those same customers.

Because the fundamental cost drivers are significantly different in the communities not served by the interconnected grid, Manitoba Hydro has two separate and distinct rate zones, grid and diesel.

Diesel Zone Rates

As of 2004, Manitoba Hydro's diesel zone rates for residential and non-government General Service customers have been equivalent to grid rates for the first 2000kWh of energy consumed per month. They are charged the full cost rate on any further consumption. The 2000kWh limit is in place to support Manitoba Hydro's policy which prohibits use of electric space heat in these communities (the provincial average monthly consumption for residential customers with non-electric heat is in the order of 900kWh). Direct use of fossil fuels is much more efficient than producing electricity from fossil fuels for heating purposes. By using the fossil fuel to heat the home directly, significantly less fuel is used in total than if the fossil fuel was used to create electricity which was in turn used for space heating. The 2000kWh limit discourages inefficient electric heat use and reduces the requirements for diesel plant expansion.

Government and government supported accounts are charged the full cost rate plus a surcharge. The implicit subsidy to residential and general service customers is intended to be recovered through the surcharge.

Appendix 1 contains detailed information on the current rate structure of the diesel zone.

Supply Options

General

Manitoba Hydro carried out supply option screening studies for each of the communities currently served by diesel generation. These studies, completed in 2007, were preliminary in nature, for the purposes of discussing supply options within Manitoba Hydro and with external stakeholders. Copies of these reports can be found in Appendix 2.

General assumptions for the studies included:

- corporate approved economic indicators and forecasts
- 35 year study period
- 2006 20-year Diesel Price Forecast
- All costs used were in constant 2006 dollars

The reports were shared with the Chief and Council of the four diesel communities, the Mayor and Council of Brochet, and Indian and Northern Affairs Canada (INAC), with presentations on the studies given to each group at a series of meetings. Meeting minutes from the community meetings are located in Appendix 3, and the minutes from the meeting with INAC are included in Appendix 4 of this report.

The next steps in deciding to move forward with any option other than continued operation of existing diesel generating stations include but are not limited to: site investigations, detailed design of the option, license applications, environmental approvals, and project funding agreements.

The following section of this report contains a summary of the findings of the studies and community discussions.

Wind

Technical Summary

The wind option studied for each community was a low-penetration option, sized to offset 20% of each community's energy needs at continued current 60 Amp service, with the existing diesel units remaining in place. As the communities' energy needs grow, additional wind generators were assumed to be added to maintain the long term average of 20%. Twenty percent penetration is an optimistic estimate, as it is anticipated that integrating the generation from wind turbines with the diesel generators would pose a technical challenge related to the ability to efficiently operate the diesel units with variations in load and wind generation with minimum investment in upgrades or modifications. These issues need to be further explored and resolved in subsequent studies if a wind-diesel option were pursued in these communities.

Information available from the National Renewable Energy Laboratory (NREL) indicates that there has been some success to date with these types of wind-diesel installations in remote Arctic communities, and with systems that incorporate more aggressive diesel generation offsets. These installations do not come without problems; however experience to date has been that any issues encountered have been manageable.

The study assumed that 20% offset would require little modification to the existing diesel generating stations, except in locations where the existing generators were considered too large to efficiently follow variations in wind energy production. This option also assumed the diesel generating stations need to be maintained and expanded exactly as planned for continued operation on diesel alone. As there would be times when the wind facilities produce no power, the diesel generating stations needed to be able to serve 100% of the community load at all times.

Each wind generation facility was expected to have a regulatory timeframe of up to one year, and a construction period of 1 to 2 years.

Fuel consumption and associated emissions reductions were assumed to be up to 20% or about 1600 tonnes annually. The actual emission reductions and fuel savings would depend on the amount of wind generation and the ability to absorb it into the system.

Capital Cost Summary

The capital cost to construct a wind generation facility to offset 20% of diesel fired generation in all four communities was in the range of $21 to $40 million (2006 dollars).

Community Comments

The communities did not communicate that they perceived the potential to reduce fuel and emission by up to 20% as a strong benefit, although some concern was expressed about the reliability of wind generation. In general the response to this option was fairly neutral.

Small Hydro

Technical Summary

A 5.2MW hydro generating station to supply power to both Brochet and Lac Brochet was reviewed as part of the screening studies. For both the 60Amp and 200Amp supply options the design option consisted of four 1.3 MW turbines with a transmission line connecting both communities. The assumed design was a shore-to-shore structure on the Cochrane River, 14 km northeast of Brochet, which would create minimal flooding, but store adequate water to supply approximately 24 hours of demand.

Since energy available to a small hydro facility is dependent on stream flow, this option included maintaining diesel generation for peaking requirements and back up generation during low water years or when hydro units were unavailable. The design concept of one common generating station to serve both communities was judged to be the most cost effective option. Although it would be possible to develop a further site to meet 100% of the forecast demand for 60 or 200 Amp service, this would increase the cost significantly compared to a single generation station. For this level of study, it was determined that a single station concept would provide an adequate indication of the magnitude of investment required for a small hydro option for comparison with other options identified. Multiple generating stations, or larger stations that could serve larger loads but with greater potential physical impacts, could be considered if further investigation of small hydro as a power supply option is pursued.

To maintain the 60A service in Brochet and Lac Brochet, the small hydro option required maintaining one diesel site for back up for peak load under low flow conditions. Under average flow conditions, the small hydro option was able to serve the peak demand and annual energy requirements for both communities. Although average flow conditions would supply enough generation to meet all demand during the study period, the study assumed some diesel generation was required to ensure reliability of the diesel units and their availability during less than average flows when needed to help meet demand. This resulted in a 99% GHG emission reduction over the study period under average flow conditions.

For 200A service, the small hydro supply option would not provide enough energy to completely offset diesel generation for annual energy needs under average flow conditions, and required maintaining both diesel sites for back up during peak demand and during low flow years. Under average flow conditions in early years of the study, the diesel units were required to run only for reliability, providing 1% of the communities' energy needs. By the end of the study period, the diesel units were providing 19% of the energy demand when required to help meet peak demand. The increase in expected diesel generation compared to the 60 Amp service option is due to the increased demand expected as customers convert to electric space heating. In total, the small hydro option resulted in offsets of approximately 81% of total GHG emissions, assuming average flows throughout the study period.

The project was assumed to have a regulatory timeframe of 4 years and to take approximately 3 years to construct. The study did not investigate the potential to accelerate the project schedule, which would include streamlined licensing requirements.

Small hydro generation was not studied as an option for Shamattawa or Tadoule Lake due to environmental and technical issues, as well as a lack of information on local stream flow properties and site suitability for small hydro development to properly assess small hydro potential in the vicinity of these communities.

Capital Cost Summary

The capital cost estimate ranged between $34 and $63 million for 60A service (2006 dollars). For 200A service, the capital costs would increase between 6 to 8%.

Community Comments

Concerns were expressed over the potential environmental effects that small hydro development may have. They stated that their views were based on what they had observed on past large hydro developments. Communities who saw potential in developing a hydro facility expressed interest in the community developing and owning the facility.

Transmission Lines

Technical Summary

The transmission line option reviewed as part of the screening studies for Brochet, Lac Brochet, and Tadoule Lake consisted of a 138kV line originating at Lynn Lake extending to Brochet, and a 66kV line from Brochet to Lac Brochet, terminating in Tadoule Lake. The total line length to connect all three communities was approximately 385 km. For the purposes of the study, the project was assumed to have a regulatory timeframe of 2 years, and to take approximately 3 to 4 years to construct.

The 138kV transmission line reviewed in the Shamattawa screening study would originate at the Radisson Station Northeast of Gillam, with a line length of approximately 170 km to Shamattawa. For the purposes of the study, the project was assumed to have a regulatory timeframe of 2 years, and to take approximately 1 to 2 years to construct..

This option provides 200A service to the communities and would completely eliminate the need to maintain the diesel generating sites in all four communities, thereby eliminating GHG emissions.

A more recent review of the transmission line option carried out by Manitoba Hydro staff indicated that the communities could be served from a 66kV supply. This would result in a shorter construction and regulatory timeframe, and potentially lower capital costs.

Cost Summary

The capital cost estimate to construct a transmission line to Brochet, Lac Brochet and Tadoule Lake ranged from $94 to $178 million, and the capital cost to connect Shamattawa ranged from $41 to $77 million (2006 dollars).

Community Comments

Communities communicated that a transmission line option is the preferable non-diesel option. The benefit of grid rates, potential for electric heat and greenhouse gas reductions, and the potential for economic development opportunities with access to 200A service were mentioned.

A number of communities expressed some concern over the potential for negative effects of a transmission line on caribou migration.

Communities commented on the potential benefits of possibly combining the development of a transmission line with developing a permanent road to the communities.

Other Generation Technologies

Solar Photovoltaics

In order to serve a significant portion of diesel community energy needs, a solar option would require the construction of a large solar energy facility, and the continued maintenance and operation the existing diesel generating stations. This option was excluded from the screening studies because it is not yet considered practical for large scale applications, has unproven reliability and maintainability in extreme weather conditions, and is not a dispatchable resource. The current technology provides a very low annual capacity factor (approximately 8%). There are significant challenges related to integrating this technology with the existing diesel generators. However, this technology could be considered as a possible option for individuals to reduce residential electricity demand.

Hydrogen Fuelled Generation

Using hydrogen as an alternative fuel source in generation technology similar to the existing generating technologies was reviewed. The technology could significantly reduce greenhouse gas emissions, however, this option was excluded from the study because it is still in the research and development phase of technological development and has significant uncertainty and challenges associated with the supply, transportation, storage, and handling of hydrogen in extreme weather conditions in remote locations.

Biomass Based Thermal Generation

A biomass based generation option would include the construction and operation of a complex generating station. This option was excluded on the basis of the significant challenges associated with the handling and storage of ash, access to fuel supply, and the significant maintenance challenges associated with operating a steam power plant in a remote location without year-round road access. Fuel supply is a concern as there is no local sustainable feedstock available for an application of this magnitude, and there are significant challenges associated with long distance fuel transportation, long term storage, and fuel handling. Although the use of biomass fuel could be considered as a possible option to replace or augment the use of fuel oil for home heating, in a high efficiency wood pellet stove for example, the study of distributed options for heat or electricity supply alternatives was outside the scope of the generation supply option studies.

Biodiesel

Biodiesel is a renewable and biodegradable fuel derived from plant and animal feedstocks and has the potential of significantly reducing greenhouse gas emissions including carbon dioxide and carbon monoxide. Biodiesel can be blended with petroleum-based diesel fuel.

There are some potential challenges to implementing biodiesel in the extreme environment in remote northern locations. Specifically, the biodiesel's physical characteristics may prohibit the use of higher blends due to its inability to flow properly in very cold weather. As well there is a potential for degradation of the fuel during longer-term storage.

In February 2008, Manitoba Hydro began a pilot project, in conjunction with the Provincial government to determine the feasibility of using biodiesel to displace a portion of the petroleum-based diesel fuel currently used at these northern diesel generating facilities.

Soybean-based biodiesel was purchased and blended at a 5% ratio (B5). It was delivered to Brochet, Manitoba for storage and testing. To date, there have been no operational issues with using the B5 blend of biodiesel.

If the final results of the current pilot project are positive, a further pilot project of higher ratio blends (B10) will be undertaken. Manitoba Hydro will be looking to use Manitoba produced canola based biodiesel product in this next phase, as a local production facility is expected to begin operation in 2009.

If successful, implementing the use of B10 (canola) blend in all locations would reduce GHG by approximately 9%. Implementing the use of B5 (canola) would result in approximately 5% GHG reduction.

Biodiesel is slightly more costly than diesel. Currently the costs for B5 are in the range of 10% higher than diesel. Projections indicate that over the next 5 to 10 years biodiesel costs will remain at a premium to diesel. At a premium expected to range from 2¢ to 4¢ per liter, the cost to supply energy to all four communities would increase by $85,000 to $170,000 in 2010, assuming the same load forecasts used in the screening studies.

Supply Side Enhancements

Technical Summary

Many utilities across Canada face similar issues as Manitoba Hydro with respect to supplying service to remote locations. In an effort to share information and learn from other's experiences, Manitoba Hydro participates in the Canadian Off-Grid Utilities Association, a group of regulated utilities from across Canada that provide electricity to off-grid communities, primarily from diesel generation. The mission of the Association is in part to develop, document and advance the off-grid utility industry's technical best practices for planning, designing, developing and operating diesel generation. This is being undertaken in an effort to provide information so that the most effective and efficient diesel generation can be delivered throughout Canada.

Past Initiatives

Heat Recovery Projects

The generation of electrical energy by means of diesel engines results in the creation of waste heat. This waste heat is traditionally exhausted through the use of radiators external to the generating plant. Manitoba Hydro has been capturing a portion of this waste heat energy to provide space heat in its own facilities. The waste heat has been utilized to provide space heat to the plant facilities and staff accommodations. These initiatives have reduced the station service load, the diesel fuel consumption and the waste heat energy produced by the plant.

In addition, Manitoba Hydro has supported the installation of waste heat recovery systems to collect waste heat from diesel generation cooling systems in all four communities. The heat captured by these systems is used to prevent the towns' water and sewer systems from freezing during the winter months. Previously the water and sewer systems were protected by consuming electrical energy produced by the diesel generating stations.

The community pays an annual fee to Manitoba Hydro to maintain the residual heating systems. The fees collected are used to reduce the costs allocated to the diesel zone.

Future Initiatives

Manitoba Hydro is undertaking two research and development projects to evaluate two separate internal combustion engine performance enhancing technologies. Both technologies involve enhancement of the fuel burn that results in improved efficiency and reduced emissions. The theory of these technologies has been generally accepted however independently reported results have been mixed.

Proponents of these technologies report efficiency improvements anywhere from 10% to 20% and even greater reductions of emissions. A 10% improvement could reduce the total annual fuel consumption by 380,000 liters. If this research proves successful this technology could offer very significant benefits in terms of costs and emissions reductions.

Station service load is energy required at the generating station, it typically includes pumps, motor, lighting and space heating. In these diesel communities the station service load represents between 4% and 8% of the total energy generated by the plant. Manitoba Hydro continues to pursue opportunities to reduce the station service load, including the potential use of variable frequency drives for all plant motor loads. This initiative has the potential to reduce station service load by up to 20% and the total system load by up to 1.5%. A trial would take in the order of 18 months to install and monitor and is currently being investigated for an initial site. If successful, similar projects could be implemented at all four sites.

Demand Side Management

Technical Summary

Manitoba Hydro offers a wide range of Power Smart Programs designed to promote the adoption of energy efficient technologies. Programs are offered to both residential and commercial customers across Manitoba. Programs with the most significant impact on energy savings are those related to space heating - primarily insulation and heating systems. These programs have been extended, through the Affordable Energy Fund to all customers regardless of their heating fuel. Because direct use of fossil fuel is significantly more efficient than producing fossil fueled electricity for heating purposes, it is Manitoba Hydro's policy to prohibit the use of electric space heat in these communities. Therefore those programs with the largest potential impact on energy savings will not reduce the amount of diesel to supply electricity, but will instead reduce the amount of fuel oil used for home heating (not within the scope of this report). A report has been undertaken on demand side management potential in the diesel communities and preliminary results of the study indicate that the technical potential for energy savings (i.e. If every non-efficient technology was replaced with a more energy efficient alternative) in all diesel communities is 0.92 GWh per year which could result in a reduction of approximately 585 tonnes of greenhouse gas emissions. Typical uptake ranges from 2% to 25% depending on the program, the community, the capital investment required by the customer etc. An extremely optimistic estimate for these communities of 25% would result in 0.23 GWh or approximately 145 tonnes of annual greenhouse gas emissions.

Manitoba Hydro is working with communities to promote energy efficiency in both residential and commercial buildings. Manitoba Hydro helps the communities better understand what they can do to reduce their energy usage and provides incentives for qualifying upgrades.

INAC and Umbrella Organizations

Manitoba Hydro extended invitations to INAC to participate in the first series of meetings with the Chief and Council of each of the off-grid communities. INAC chose not to participate in these meetings.

On October 23, 2008 Manitoba Hydro met with INAC and presented the summary of work to date on the options for reducing or eliminating diesel in the four off-grid communities. Minutes of the meeting are included in Appendix 4. Manitoba Hydro will continue to inform INAC of activities related to supply options of the four diesel communities.

Participation in the meetings by umbrella organizations such as the Keewatin Tribal Council (KTC) and Manitoba Keewatinowi Okimakanak (MKO) was left to the discretion of the individual community's leadership.

Potential Funding

With respect to new infrastructure in the diesel rate zone, Manitoba Hydro, INAC and the four communities have a clear understanding that significant investments will not be made unless funding arrangements are in place. Historically these funds have either directly or indirectly flowed from INAC. The expectation is that this will continue.

Manitoba and Manitoba Hydro have submitted a proposal to the federal Green Infrastructure fund for a significant portion of the funds required to connect these four communities to the Manitoba transmission grid and remove the requirement for them to be supplied by diesel generation.

Recommendations

In order to reduce or eliminate the use of petroleum-based diesel fuel to supply power in the First Nations communities of Brochet, Lac Brochet, Shamattawa and Tadoule Lake, and the community of Brochet, it is recommended that:

- Manitoba Hydro continues the biodiesel test with a goal of maximizing the use of biodiesel without jeopardizing the current level of reliability.
- Manitoba Hydro continues to pursue supply efficiency improvements for the diesel generating stations.
- Manitoba Hydro continues discussions with the communities and INAC with respect to supply of electricity in these communities.

Monthly Electricity Rates

Effective April 1, 2009

Manitoba Hydro has implemented new electricity rates effective April 1, 2009 which incorporate a 2.9 per cent rate increase for all customer classes except Area & Roadway Lighting (for which no increase was implemented). For a typical residential customer with usage of 1,000 kilowatt-hours per month, the rate increase will amount to a bill increase of approximately $1.96 per month.

The new rates are necessary for Manitoba Hydro to maintain a financially strong corporate structure and to provide sufficient funding to pay for increased costs of operations. A financially strong Manitoba Hydro is in the interests of all Manitobans and will ensure that future rate increases will be limited or closely aligned to the rates of inflation.

With this rate increase, Manitoba electricity consumers will continue to benefit from the lowest electricity rate structure in Canada and among the lowest electricity rates in the world.

For inquiries regarding your rates,
please visit the Manitoba Hydro website at
www.hydro.mb.ca or call us at
(204) 480-5900 or 1-888-624-9376.

Manitoba
Hydro

Residential

Standard

Tariff No. 2009-01

Monthly Basic Charge:

• NOT Exceeding 200 Amp	$6.85
• Exceeding 200 Amp	$13.70

plus

Energy Charge:

First 900 kWh @	6.25c/kWh
Balance of kWh @	6.30c/kWh

Note: Minimum monthly bill is the Basic Charge.

Seasonal

Tariff No. 2009-02

Annual Basic Charge:

NOT Exceeding 200 Amp	$82.20

plus

Energy Charge: (per season)

First 5,400 kWh @	6.25c/kWh
Balance of kWh @	6.30c/kWh

Notes:

- Minimum annual bill is the Basic Charge.
- Billed in April for the Annual Basic Charge and past winter's consumption (October 16 to April 15).
- Billed in October for summer consumption only (April 16 to October 15).
- Applicable to customers using less than 7,500 kWh per billing.

Residential

Diesel

Tariff No. 2009-03

Monthly Basic Charge:	
NOT Exceeding 60 Amp	$6.85
plus	
Energy Charge:	
First 900 kWh @	6.25¢/kWh
Next 1,100 kWh @	6.30¢/kWh
Balance of kWh @	41.27¢/kWh

Notes:

- Minimum monthly bill is the Monthly Basic Charge.
- The Residential rate applies to all residential services in the Diesel Communities, provided the service capacity does not exceed 60A, 120/240 V, single phase.

General Service Small

(Non-Residential: Utility-owned Transformation NOT exceeding 200 kV.A)

Single Phase

Tariff No. 2009-20

Monthly Basic Charge:	$17.00
plus	
Energy Charge:	
First 11,000 kWh @	6.66¢/kWh
Next 8,500 kWh @*	4.48¢/kWh
Balance of kWh @	2.86¢/kWh
plus	
Demand Charge:	
First 50 kV.A	
of Monthly Measured Demand @	No Charge
Balance of Recorded Demand @	$8.34/kV.A

Three Phase

Tariff No. 2009-21

Monthly Basic Charge:	$23.74
plus	
Energy Charge:	
First 11,000 kWh @	6.66¢/kWh
Next 8,500 kWh @*	4.48¢/kWh
Balance of kWh @	2.86¢/kWh
plus	
Demand Charge:	
First 50 kV.A	
of Monthly Recorded Demand @	No Charge
Balance of Recorded Demand @	$8.34/kV.A

Notes:

- Minimum monthly bill is the Basic Charge plus Demand Charge
- Primary metering of multiple utility-owned transformation – add two per cent to kV.A for each transformation greater than one.

* Accounts where the Monthly Recorded Demand is 50 kV.A or less within the past 12 month period. ALL energy in excess of 11,000 kWh will be charged @ 4.48¢/kWh.

General Service Small

Seasonal

Tariff No. 2009-22

Annual Basic Charge:	$204.00
plus	
Energy Charge: (per season)	
First 66,000 kWh @	6.66¢/kWh
Balance of kWh @	4.48¢/kWh

Notes:

- Minimum annual bill is the Basic Charge.
- Billed in April for the Annual Basic Charge and past winter's consumption (October 16 to April 15).
- Billed in October for summer consumption only (April 16 to October 15).
- Applicable to customers using less than 7,500 kWh per billing.

Diesel General Service

Tariff No. 2009-40

Monthly Basic Charge:	$17.00
plus	
Energy Charge:	
First 2,000 kWh @	6.66¢/kWh
Balance of kWh @	41.27¢/kWh

Notes:

- Minimum monthly bill is the Monthly Basic Charge.
- The Government Service rate applies to all Commercial accounts in Diesel Communities excluding those classed as Government.

General Service Small

Diesel Government & First Nation Education

Tariff No. 2009-41

Monthly Basic Charge:	$17.00
plus	
Energy Charge:	138.363¢/kWh

Notes:

- Minimum monthly bill is the Monthly Basic Charge.
- A surcharge of 97.093¢ per kWh is included in the Government and First Nation Education tariff which applies to all Federal and Provincial Departments, Agencies, Crown Corporation accounts and First Nation Education accounts.
- The First Nation Education rate is applicable to all Diesel First Nation facilities providing instructional services for members of the Diesel First Nations, including schools, teacherages and student residences, and which receive funding in support of the costs of providing instructional services in accord with the March 31, 1998 INAC Capital Facilities and Maintenance and Operation and Maintenance Manual, in respect of funding in support of instructional services.

General Service Medium
(Non-Residential: Utility-owned Transformation exceeding 200 kV.A)

Tariff No. 2009-30

Monthly Basic Charge:	$27.60
plus	
Energy Charge:	
First 11,000 kWh @	6.42¢/kWh
Next 8,500 kWh @	4.48¢/kWh
Balance of kWh @	2.86¢/kWh
plus	
Demand Charge:*	
First 50 kV.A of Monthly Recorded Demand @	No Charge
Balance of Recorded Demand @	$8.34/kV.A

Notes:

- Minimum monthly bill is the Basic Charge plus Demand Charge.
- Primary metering of multiple Utility-owned transformation – add two per cent to kV.A for each transformation greater than one.

  * Demand Charge is applied to the Monthly Billing Demand defined as the greater of the following expressed in kV.A:

  i) measured demand.
  ii) 70% of highest measured demand in the Billing Year** for the months of December, January, February.
  iii) 25% of contract demand.
  iv) 25% of the highest measured demand in any of the previous 12 months.

  ** Billing year – Twelve monthly billing periods commencing with the month of December and ending the following November.

General Service Large

(Non-Residential: Customer-owned Transformation)

Exceeding 750 V but NOT exceeding 30 kV

Tariff No. 2009-60

Energy Charge: 2.73¢/kWh
plus
Demand Charge*: $7.08/kV.A

Exceeding 30 kV but NOT exceeding 100 kV

Tariff No. 2009-61

Energy Charge: 2.58¢/kWh
plus
Demand Charge*: $6.06/kV.A

Exceeding 100 kV

Tariff No. 2009-62

Energy Charge: 2.52¢/kWh
plus
Demand Charge:* $5.40/kV.A

Notes:

- Minimum monthly bill is the Demand Charge.

  * Demand Charge is applied to the Monthly Billing Demand defined as the greater of the following expressed in kV.A:

  i) measured demand.
  ii) 70% of highest measured demand in the Billing Year** for the months of December, January, February.
  iii) 25% of contract demand.
  iv) 25% of the highest measured demand in any of the previous 12 months.

  ** Billing year – Twelve monthly billing periods commencing with the month of December and ending the following November.

MANITOBA HYDRO

GENERATING RESOURCE SCREENING STUDY

SYNOPSIS: Preliminary analysis of potential centralized supply options that may reduce or eliminate 60 Amp diesel-fired generation in non grid-connected communities.

LOCATION: Brochet and Lac Brochet

ORIGINAL ISSUE: April 2007
REVISED: January 2008
FINALIZED: November 2008

PROVINCE OF MANITOBA
B. E.
JOHNSON
Member
24823
REGISTERED PROFESSIONAL ENGINEER

Executive Summary

As part of its ongoing planning activities and in response to requests from various stakeholders, Manitoba Hydro performed a preliminary analysis of potential alternatives to diesel-fired power generation for the communities of Brochet and Lac Brochet. This analysis is intended to provide preliminary information to determine if more detailed analysis of a particular option is warranted.

Based on a technical and environmental screening process that considered several alternatives, three options were chosen for preliminary analysis; wind power, small hydro, and connection to the Manitoba transmission grid. Wind power must be used in conjunction with the existing diesel stations and is therefore limited to 60 amp service. Small hydro was analyzed at both the 60 and 200 amp service levels. Connection to the transmission grid enables 200 amp service.

The environmental, socioeconomic, and cost characteristics associated with each option were analyzed relative to continued operation of the diesel generating stations in order to allow incremental comparisons of the alternative supply options to ongoing diesel operation. The economic analyses of the options are presented in terms of the net present value of each option relative to continued operation of the diesel stations and in terms of "break-even" fuel price. The break-even fuel price represents the fuel price at which the cost of continued operation of the diesel stations is equivalent to the estimated cost of the option under evaluation, resulting in a net present value of zero. For comparative purposes, the average annual delivered fuel prices associated with Manitoba Hydro's 2006 price forecasts are $0.86 per Litre at Brochet and $0.95 per Litre at Lac Brochet.

The incremental capital and operating costs associated with each option have been evaluated without consideration for which party would be responsible for incurring these costs. A more detailed analysis would take this into consideration and Manitoba Hydro would require contributions from the benefiting parties prior to undertaking any capital expenditures associated with the installation of new generation options.

Table 1 summarizes the results of the analysis of the 60 amp options relative to continued operation of the existing diesel generators.

Table 1 – Summary of Preliminary Analysis of 60 Amp Options Performance Relative to Continued Diesel Operation

(NPV at 6% real discount rate, 35 year study period, 2006 $CDN)

Aspect	Wind Power Augmentation Brochet (60 amp)	Wind Power Augmentation Lac Brochet (60 amp)	Small Hydro (60 amp)
Reliance on Diesel Power	Minor Reduction	Minor Reduction	eliminate (average flows)
Local Air Quality Effects	Minor Reduction	Minor Reduction	eliminate (average flows)
Terrestrial Effects	Minor increase	Minor increase	Significant Increase
Aquatic Effects	No change	No Change	Significant Increase
Socioeconomic Benefits	Minimal	Minimal	Minimal
Climate Change Implications	Minor Reductions	Minor Reductions	Significant Reductions
Incremental NPV @ Forecast Fuel Prices (2006 $CDN)	$2,000	$218,000	-$6,440,000
Break-Even Fuel Price ($ per Litre) Based on continued operation of 60 Amp diesel stations	$0.833	$0.866	$1.129
Total Capital Cost Over Study Period (2006 $ CDN)	$5,000,000	$5,840,000	$41,760,000

It must be noted that the annual wind energy assumed in this evaluation is now considered optimistic for a low-penetration option. The 20% annual energy assumption was made based on information available at the time. The level of achievable instantaneous capacity penetration is another limiting factor that will need to be investigated and addressed if this option is identified for further study. Manitoba Hydro is currently evaluating potential wind penetration levels further for the remote diesel communities based on both instantaneous capacity and annual energy penetration criteria. Should these evaluations indicate that achievable penetration levels are lower than those assumed in this study, the resulting reductions in diesel generation are expected to result in reduced economic benefits for the wind/diesel option.

As for the 60 Amp options, the net present value of the 200 amp options is incremental to continued 60 amp diesel operation. The analysis of 200 amp options does not include the costs associated with conversion of individual residences to accept 200 amp service or the cost savings associated with switching to electricity for home heating.

For the transmission connection option, the present value marginal cost of the energy required to supply the forecast 200 Amp demand for these communities is estimated to be $14,170,000 over the study period assuming a marginal cost of $0.056/kWh. However, since this option would see the communities absorbed into the general rate base and eliminate the existing "islanded" cost recovery structure, the incremental NPV of the transmission option is provided with and without the marginal cost of energy to allow comparisons to the "islanded" options with and without consideration of this cost. Table 2 summarizes the results of the analysis of the 200 amp options.

Table 2 – Summary of Preliminary Analysis of 200 Amp Options Performance Relative to Continued Diesel Operation

(NPV at 6% real discount rate, 35 year study period, 2006 $CDN)

Aspect	Small Hydro (200 amp)	Transmission Connection (200 amp)
Reliance on Diesel Power	significant reduction (average flows)	Eliminate
Local Air Quality Effects	significant reduction (average flows)	Eliminate
Terrestrial Effects	Significant Increase	Significant Increase
Aquatic Effects	Significant Increase	Significant potential decrease as it eliminates potential for diesel fuel spills
Socioeconomic Benefits	Minimal	Minimal
Climate Change Implications	Significant Decrease	Local GHG emissions eliminated. May not decrease near-term global GHG emissions.
Incremental NPV @ Forecast Fuel Prices (2006 $CDN)	-$14,080,000	-$22,660,000 (excluding marginal energy cost) -$36,830,000 (including marginal energy cost)
Break-Even Fuel Price ($ per Litre) Based on continued operation of 60 Amp diesel stations	$1.487	$1.709 (excluding marginal energy cost) $2.217 (including marginal energy cost)
Total Capital Cost Over Study Period (2006 $ CDN)	$45,080,000	$68,510,000

Connection to the transmission grid is the only option that eliminates diesel generation and provides 200 amp service. The wind power option results in a reduction in diesel generation, however a more detailed study using site-specific wind resource data is required before an accurate determination of wind generation potential can be made. The 60 amp small hydro option eliminates diesel generation under average flow conditions, but requires diesel back up under dependable flow conditions. The 200 amp small hydro option requires diesel back up under both average and dependable flow conditions. The incremental socioeconomic benefits associated with all options are minimal, with construction activities providing the majority of the benefits in all cases.

The assumed routing of the transmission line is from Lynn Lake to Brochet and then from Brochet to Lac Brochet. If Tadoule Lake is also to be connected to the grid, the connection would originate in Lac Brochet. However, if the transmission option is not implemented for Brochet and Lac Brochet, it will likely not be available for Tadoule Lake since the cost of constructing a line from Lynn Lake to Tadoule Lake alone would be prohibitive.

This preliminary analysis is intended to provide only comparative indications of the attractiveness of the supply options relative to continued operation of the diesel generating stations. Should one or more of the options be selected as potential candidates for further consideration, more rigorous environmental, socioeconomic, and economic evaluations will be required for decision-making purposes.

EXECUTIVE SUMMARY i

1.0 INTRODUCTION 1

2.0 TECHNICAL & ENVIRONMENTAL SCREENING OF POTENTIAL SUPPLY OPTIONS 3

3.0 PRELIMINARY ANALYSIS OF SELECTED SUPPLY OPTIONS 5

3.1 Current State – Continued Operation of Diesel Generating Stations 5
- 3.1.1 Overview of Option 5
- 3.1.2 Environmental Effects 6
- 3.1.3 Climate Change Implications 6
- 3.1.4 Socioeconomic Benefits 7
- 3.1.5 Cost Analysis 7

3.2 Option 1 – Augmenting Diesel Generation with Wind Power 9
- 3.2.1 Overview of Option 9
- 3.2.2 Incremental Environmental Effects 10
- 3.2.3 Incremental Climate Change Implications 11
- 3.2.4 Incremental Socioeconomic Benefits 11
- 3.2.5 Incremental Economic Analysis 11
- 3.2.6 Summary 13

3.3 Option 2 – Small Hydroelectric Generation 14
- 3.3.1 Overview of Option 14
- 3.3.1a Adequacy of the 60 Amp Service Option 15
- 3.3.1b Adequacy of the 200A Service Option 16
- 3.3.2 Incremental Environmental Effects 16
- 3.3.3 Incremental Climate Change Implications 17
- 3.3.4 Incremental Socioeconomic Benefits 18
- 3.3.5 Incremental Economic Analysis 18
- 3.3.6 Summary 20

3.4 Option 3 – Connection to the Transmission Grid 21
- 3.4.1 Overview of Option 21
- 3.4.2 Incremental Environmental Effects 22
- 3.4.3 Incremental Climate Change Implications 22
- 3.4.4 Incremental Socioeconomic Benefits 23
- 3.4.5 Incremental Economic Analysis 23
- 3.4.6 Summary 26

4.0 HOME HEATING COST IMPLICATIONS OF 200 AMP SERVICE OPTIONS 27

APPENDIX A - TECHNICAL & ENVIRONMENTAL SCREENING OF POTENTIAL SUPPLY OPTIONS A-1

APPENDIX B - SUMMARY OF ASSUMPTIONS B-1

1.0 Introduction

Manitoba Hydro operates reciprocating diesel generating units to supply power to the remote communities of Brochet, Lac Brochet, Shamattawa, and Tadoule Lake. This report summarizes the preliminary analysis of several potential supply alternatives for the communities of Brochet and Lac Brochet. Subsequent reports will be prepared for the communities of Shamattawa and Tadoule Lake.

While there are no operational or reliability concerns associated with the existing diesel generating stations at Brochet and Lac Brochet, Manitoba Hydro regularly evaluates opportunities to improve the performance of these assets. In addition, the PUB, Indian and Northern Affairs Canada (INAC), MKO, and other stakeholders have expressed interest in reducing or eliminating the use of diesel for power generation at these sites and in reducing the cost of service in off-grid communities.

The scope of this preliminary analysis includes the following;

- Identification of potential non-fossil fuel burning centralized power generation technologies that may be used to either reduce or eliminate continued diesel generation in the communities of Brochet and Lac Brochet
- Connection to the transmission grid
- Analysis of the environmental effects, social effects, and costs associated with potential alternative power generation resources
- Identification and analysis of resource options that provide 200 amp service

The scope of this analysis does not include;

- Analysis of distributed power generation options, such as solar panels
- Analysis of demand side management opportunities available to the communities as these were assumed to affect all potential supply options equally
- Analysis of combined heat and power applications
- Detailed analysis of home heating options and associated costs available to individual residences and businesses
- Analysis of the costs that individual residences and business may incur to upgrade to 200 amp service
- Soil remediation costs. Only diesel site decommissioning costs were considered

These analyses are preliminary in nature and are intended to provide only comparative indications of the attractiveness of the supply options relative to continued operation of the diesel generating stations. Should one or more of the options be selected as potential candidates for further consideration, more rigorous environmental, socioeconomic, and economic evaluations will be required for decision-making purposes.

2.0 Technical & Environmental Screening of Potential Supply Options

Potential supply options were restricted to those that either reduce or eliminate the use of diesel-fired generation. The options that met this objective were then assessed on the basis of the following 5 parameters in order to identify those options that are appropriate for this application;

- State of Technological Development – is the technology commercially available and proven?
- Reliability & Maintainability – will the option perform reliably in severe cold weather conditions and can the option be maintained in a remote location with limited road access?
- Dispatchability – can the option be dispatched to meet demand?
- Fuel Supply – what are the fuel supply availability, transportation, storage, and handling issues associated with the option?
- Environmental Effects – what are the major environmental effects on land, air, and water associated with the option?

Appendix A provides a summary of the results of the technical and environmental screening exercise. The options selected for preliminary analysis based on this exercise are as follows;

- *Option 1 – Augmenting Diesel Generation with Wind Power.* This option will reduce diesel generation. Replacement is not feasible because wind is not dispatchable and must therefore be used in combination with other sources of dispatchable power. This analysis assumes that wind will be used in combination with the existing diesel generators to ensure a continuous, reliable supply of power.
- *Option 2 – Mini Hydroelectric Generation.* This option would significantly reduce diesel generation under all flow conditions. Diesel generation will always be required to augment energy production depending on actual flow conditions.
- *Option 3 – Connection to the Transmission Grid.* This option has the ability to completely eliminate the requirement diesel generation at Brochet and Lac Brochet.

The option of supplying 200 Amp service with diesel generators was considered but was screened out. The main driver for increasing service from 60 Amps to 200 Amps in the communities of Brochet and Lac Brochet is the use of electricity for residential space heating. However, using diesel to heat a home directly with a liquid fuel furnace is approximately 1.9 to 2.8 times more efficient than using diesel to generate electricity which is then used to heat a home with resistive heaters. Therefore, the use of diesel generators to supply 200 Amp service to supply additional electricity for residential space heating would result in a significant increase in diesel consumption and associated emissions relative to 60 Amp operation. This option was therefore screened out for further evaluation as it does not meet the objective of reducing or eliminating the use of diesel-fired generation.

3.0 Preliminary Analysis of Selected Supply Options

The three supply options were evaluated on the basis of their environmental, social, and cost characteristics relative to continued operation of the diesel generating stations at Brochet and Lac Brochet. In addition, the climate change implications of the options are discussed.

The existing diesel generating stations in Brochet and Lac Brochet are assumed to continue normal operation until each option is fully installed and operational. Given the varying construction and regulatory lead times associated with the options, the assumed in service dates may be delayed based on the timing of a decision to commit to a particular option.

The economic analyses of the options are presented in terms of the net present value of each option relative to continued operation of the diesel stations and in terms of "break-even" fuel price. The break-even fuel price represents the fuel price at which the cost of continued operation of the diesel stations is equivalent to the estimated cost of the option under evaluation, resulting in a net present value of zero.

Manitoba Hydro's intention is to share this screening study with the communities, their representatives and INAC for their review, comment and further discussion. As Manitoba Hydro's policy with respect to service extension is that the customer or customer group requesting or benefiting from the provision of service must pay for the service, discussions regarding funding and commitments must be in place prior to progressing to the next stage of detailed evaluation and design.

3.1 Current State – Continued Operation of Diesel Generating Stations

3.1.1 Overview of Option

The diesel generating station at Brochet includes two 1,015 kW units and one 600 kW unit for a station total capacity of 2,630 kW. The diesel generating station at Lac Brochet includes one 175 kW unit, three 425 kW units, and one 855 kW unit for a station total capacity of 2,305 kW. Additional reciprocating diesel generating units will be added at each station to meet increases in electrical demand over time.

The diesel generators installed at these stations have thermal efficiencies in the range of 34% to 36% which is on par with current reciprocating diesel engine technology. Future improvements in diesel engine technology may provide opportunity to install more thermally efficient units as existing units reach the end of their service lives, but thermal efficiency improvements are not currently anticipated to be significant as diesel engine technology is mature with little significant research and development taking place.

Potential soil remediation costs associated with past, present, or future operation of the diesel sites have not been included in this analysis.

3.1.2 Environmental Effects

Local Air Quality Effects – operation of diesel generators results in emissions of NOx, SOx, CO, CO2, fine particulate matter, and unburned hydrocarbons (UHC). In addition, diesel generators produce constant process noise.

Terrestrial Effects – operation of diesel generators requires land use for the generating station, the fuel storage tank farm, access roads to the station and tank farm, and the transmission lines from the station. Diesel fuel spill potential is associated with the operation of the fuel storage facilities and associated piping which can result in soil, surface, and ground water contamination. There is also spill potential associated with fuel transportation.

Aquatic Effects – operation of diesel generators does not require water withdrawal and involves no liquid effluent streams. The greatest risk to aquatic life occurs during the diesel truck haul over the winter road system and the ever present potential of vehicle and load loss due to bad ice conditions.

3.1.3 Climate Change Implications

Over the study period from 2006 to 2041, CO2 emissions associated with operation of the Brochet diesel generating station will total approximately 0.11 megatonnes based on Manitoba Hydro's 2006 load forecasts. This is equivalent to 16,000 vehicles operating normally for one year. This translates to an annual average of 3,100 tonnes, which is equivalent to 450 vehicles operating normally for one year, or approximately 0.015% of Manitoba's total annual GHG emissions.

Total CO2 emissions over the study period associated with operation of the Lac Brochet diesel generating station will be approximately 0.13 megatonnes based on Manitoba Hydro's 2006 load forecasts. This is equivalent to 18,000 vehicles operating normally for one year. This translates to an annual average of 3,600 tonnes, which is equivalent to 500 vehicles operating normally for one year, or approximately 0.018% of Manitoba's total annual GHG emissions.

One of the potential effects of climate change is increased and more extreme ambient temperature variability. This poses fuel transportation risk due to potential decreases in the duration of the winter road season. In addition, potential challenges to maintaining adequate on site fuel supplies will be associated with increased and more extreme temperature variability.

3.1.4 Socioeconomic Benefits

One plant operator is employed in each community and maintenance activities provide contract employment to local residents. In addition, each community receives an economic benefit of approximately $0.03/L from the diesel fuel that is consumed for power generation.

3.1.5 Cost Analysis

The present value cost of continued operation of the diesel generating stations at Brochet and Lac Brochet was calculated over 35 years (2006 to 2041) using a real discount rate of 6%. Since the delivered cost of diesel fuel is the dominant cost associated with the operation of diesel generators, the economic analyses were performed using Manitoba Hydro's 2006 delivered diesel fuel price forecasts for each community (with delivered prices that vary from year to year) and at various constant annual fuel prices in order to determine the sensitivity of the results to fuel price. The delivered fuel price forecasts differ for each community due to differences in transportation costs. Costs associated with air emissions have not been included in these analyses. Table 1 provides the results of the present value cost analyses for Brochet and Lac Brochet.

Table 1 – Present Value Cost of Continued Diesel Generation at Brochet and Lac Brochet

Delivered Fuel Price ($/Litre)	Brochet (PV,2006 $CDN)	Lac Brochet (PV,2006 $CDN)
MH 2006 Brochet Price Forecast	*$22,050,000*	*N/A*
MH 2006 Lac Brochet Price Forecast	*N/A*	*$27,860,000*
$0.70	$19,140,000	$22,740,000
$0.80	$20,920,000	$24,820,000
$0. 90	$22,700,000	$26,900,000
$1.00	$24,480,000	$28,980,000
$1.10	$26,250,000	$31,060,000

The average annual delivered fuel prices associated with Manitoba Hydro's 2006 price forecasts are $0.86 per Litre at Brochet and $0.95 per Litre at Lac Brochet.

3.2 Option 1 – Augmenting Diesel Generation with Wind Power

3.2.1 Overview of Option

Wind generation is not dispatchable to meet demand and therefore must be used in combination with the existing diesel generators at Brochet and Lac Brochet to ensure a continuous, reliable supply of power to these communities. This option will decrease, but will not eliminate the use of diesel generation. In addition, since this option works in combination with the existing diesel generators, the communities would continue to be provided with 60 Amp service.

In order to determine the feasibility of installing wind generation in combination with existing diesel generators, Manitoba Hydro retained Global Energy Concepts, LLC (GEC) in 2006 to conduct preliminary feasibility studies for the communities of Brochet, Lac Brochet, Tadoule Lake, and Shamattawa. The recommendations and results of GEC's study formed the basis of Manitoba Hydro's preliminary analysis of the use of wind power in Brochet and Lac Brochet.

Since no site-specific wind resource data were available, GEC utilized data from the *Canadian Wind Energy* Atlas and Environment Canada to estimate the wind resource potential for Brochet and Lac Brochet. Site-specific wind data will be required if this option is selected for more detailed analysis.

GEC recommends that wind energy installations in the off-grid communities be initially limited to 20% of annual energy demand (20% penetration) until sufficient operating experience is gained with the operation of wind-diesel systems. Alaskan communities that operate wind-diesel systems have found this level of penetration compatible with existing diesel generators without requiring costly and sophisticated controls and voltage stability equipment. For these reasons, Manitoba Hydro based its analysis of the wind-diesel option on a penetration level of 20% in each community.

It must be noted that the annual wind energy assumed in this evaluation is now considered optimistic for a low-penetration option. The 20% annual energy assumption was made based on information available at the time. The level of achievable instantaneous capacity penetration is another limiting factor that will need to be investigated and addressed if this option is identified for further study. Manitoba Hydro is currently evaluating potential wind penetration levels further for the remote diesel communities based on both instantaneous capacity and annual energy penetration criteria. Should these evaluations indicate that achievable penetration levels are lower than those assumed in this study, the resulting reductions in diesel generation are expected to result in reduced economic benefits for the wind/diesel option.

The wind turbine assumed in this analysis is the Fuhrländer FL250. This is a 250 kW wind turbine with a tower height of 42 m that can operate in ambient temperatures as low as -40°C. Fuhrländer is designing a tilt-up tower for this model which does not require a crane for erection. Since the tower design is not commercially available, GEC estimated the capital cost of the unit based on the use of custom-designed towers. The capital cost estimate has a range of uncertainty of -10% to +30%. For this analysis, Manitoba Hydro assumed the GEC capital cost estimate plus 15% to account for transmission equipment and the construction of access roads to the wind turbines

Wind turbines would be located at each site to operate in combination with the existing diesel generators. Wind turbines would be added as energy demand grows to maintain the 20% penetration target. At Brochet, turbines are assumed to be installed as follows; two turbines in 2012, a third turbine in 2020, and a fourth turbine in 2036. At Lac Brochet, turbines are assumed to be installed as follows; three turbines in 2012 and a fourth turbine in 2027.

It is anticipated that this option would not require an Environment Act Licence or Federal screening and would be subject only to Provincial review which would require a maximum of one year to complete.

3.2.2 Incremental Environmental Effects

Local Air Quality Effects – this option will result in a net reduction in emissions of NOx, SOx, CO, CO2, fine particulate matter, and UHC. associated with diesel generation. Since a penetration level of 20% is assumed in this analysis, it can reasonably be assumed that a similar annual decrease in these emissions would be associated with this option.

Terrestrial Effects – this option will result in a net increase in the land use associated with power generation as additional land will be required for the erection of wind turbines, access roads to the turbines, and transmission lines from the turbines. Construction phase terrestrial effects are expected to be minimal.

Wind turbines also have the potential for bird strikes. Limited available information suggests that Brochet and Lac Brochet may be on the flanks of the Mississippi Migration Flyway. If true, this would suggest that large numbers of Snow and Canada Geese could migrate through both areas. Based on information from the St. Leon area approximately 80% of typical bird flight heights would be either below or above the blade heights (35M – 65M). In addition, there are no known bird species at risk as defined by either the SARA MESA Acts in the project area.

Aquatic Effects – this option will result in no change to the aquatic effects associated with diesel generation. Construction phase aquatic effects are expected to be minimal.

3.2.3 Incremental Climate Change Implications

This option will result in a 20% reduction of GHG emissions relative to continued diesel-only power generation. At Brochet, CO2 emissions over the study period are estimated to be 0.089 megatonnes, equivalent to 12,000 vehicles operating normally for one year. At Lac Brochet, CO2 emissions over the study period are estimated to be 0.105 megatonnes equivalent to 15,000 vehicles operating normally for one year.

By reducing diesel fuel requirements, this option will decrease GHG emissions associated with fuel transportation and decrease the fuel transportation risk and fuel supply challenges associated with diesel power generation.

3.2.4 Incremental Socioeconomic Benefits

With duration of construction anticipated to be no more than 6 months, limited incremental opportunities for training and employment exist for this option. Operational responsibilities would be assumed by the existing diesel operators in the communities. Infrequent service requiring specialized skills would be outsourced beyond the community because the volume of work would not be sufficient to maintain local proficiency.

There is some potential for short term direct business opportunities from this option, such as the transport of towers, blades and turbines; provision of project infrastructure; and erection of towers, and as with training and employment, the duration of opportunities is likely limited to construction. Existing capacity within the community is limited. Partnership with experienced companies would likely be required.

3.2.5 Incremental Economic Analysis

The net present value of augmenting diesel generation with wind power relative to status quo continued diesel generator operation was calculated over 35 years (2006 to 2041) using a real discount rate of 6% and assuming an annual wind power penetration ratio of 20%. Since the delivered cost of diesel fuel is the dominant cost associated with the operation of diesel generators, the economic analyses were performed using Manitoba Hydro's 2006 delivered diesel fuel price forecast (with an annual forecast price which varies from year to year) and at various constant annual fuel prices in order to determine the sensitivity of the results to fuel price and to determine the break-even fuel price for the options. Due to regulatory uncertainty, these analyses do not include a cost for CO2 emissions. Table 3 provides the results of the economic analyses for Brochet and Lac Brochet.

Table 3 – NPV of Augmenting Diesel Generation with Wind Power in Brochet and Lac Brochet Relative to Continued Diesel Generation
(NPV at 6% real discount rate, 35 year study period, 2006 $CDN)

Delivered Fuel Price ($/Litre)	Brochet (NPV,2006 $CDN)	Lac Brochet (NPV,2006 $CDN)
MH 2006 Brochet Price Forecast	*$2,000*	*N/A*
MH 2006 Lac Brochet Price Forecast	*N/A*	*$218,000*
$0.70	-$359,000	-$527,000
$0.80	-$89,000	-$210,000
$0.833	$0	-$105,000
$0.866	$89,000	$0
$0.90	$181,000	$108,000
$1.00	$451,000	$425,000
$1.10	$721,000	$742,000

The break-even delivered fuel prices for this option are $0.833 per Litre for Brochet and $0.866 per Litre for Lac Brochet. The average annual delivered fuel prices associated with Manitoba Hydro's 2006 price forecasts are $0.86 per Litre at Brochet and $0.95 per Litre at Lac Brochet.

Based on Manitoba Hydro's forecast prices and approximate wind resource information, augmenting diesel generation with wind power in Brochet and Lac Brochet is essentially a break-even option. That is, the reduction in diesel fuel cost is approximately equal to the capital and operating costs that would be incurred to install wind generation.

3.2.6 Summary

Table 4 summarizes the preliminary analysis of augmenting diesel generation with wind power for Brochet and Lac Brochet.

Table 4 – Summary of Option 1 – Wind Power

Aspect	Performance Relative to Continued Diesel Operation	
	Brochet	**Lac Brochet**
Reliance on Diesel Power	Minor Reduction	Minor Reduction
Local Air Quality Effects	Minor Reduction	Minor Reduction
Terrestrial Effects	Minor increase	Minor increase
Aquatic Effects	No change	No Change
Socioeconomic Benefits	Minimal	Minimal
Climate Change Implications	GHG reduction, Decreased transportation risk	GHG reduction, Decreased transportation risk
NPV @ Forecast Fuel Prices	$2,000	$218,000
Break-Even Fuel Price	$0.833 per Litre	$0.866 per Litre

3.3 Option 2 – Small Hydroelectric Generation

3.3.1 Overview of Option

This analysis examines two small hydro options; 1. The development of one small hydro site to serve the combined demand from Brochet and Lac Brochet both communities at the existing 60 Amp level of service, and 2. The same hydro site to serve the combined demand from Brochet and Lac Brochet at an upgraded 200 Amp level service. While not considered in this analysis, an option that may be considered for future study is the construction of dedicated hydro stations for each community if the small hydro option is selected for further analysis.

The hydro site assumed in this analysis is referred to as "site L-3" and is located approximately 14 km northwest of Brochet on the Cochrane River. The characteristics of this site were estimated by Manitoba Hydro in 1984 and have not been updated for this analysis.

The L-3 site provides 5.5m of hydraulic head, with a dependable (low) flow of 55 m^3/s and an average flow of 149 m^3/s, based on monthly flow records from 1952 to 1983. These assumptions do not account for the potential effects of ice on station operations, which could diminish dependable flows during the winter months of low flow years.here may also be regulatory constraints that stipulate a minimum flow by-pass during low-flow years which may reduce useable dependable flows. Dependable capacity at this site is approximately 2.6MW and average capacity is approximately 7.1 MW.

The assumed small hydro station is a shore-to-shore structure, containing an overflow weir to allow water by-pass. Approximately 10 hectares of land would be cleared to construct a forebay for the station. The station would house four 1.3 MW (nominal) units, all of which are assumed to be installed in 2012. The capital cost estimate used in this analysis has a range of accuracy of +/- 50% and includes all generating station infrastructure and equipment, transmission lines and equipment, and site access roads. Costs associated with upgrading the distribution systems from 60 amp to 200 amp service were included in this analysis. However, costs associated with upgrading individual residences and business to accept 200 amp service have not been included.

This analysis assumes that the small hydro station is built to its full capacity for both the 60 Amp and 200Amp options. While this assumption may result in surplus energy and capacity associated with the station, it meets the objective of reducing or eliminating diesel generation and makes the 60 Amp and 200 Amp small hydro options directly comparable.

Dependable hydro generation capacity was used as the criteria to determine the diesel capacity requirements to meet forecast peak load for the combined communities under drought conditions. Under dependable flow conditions, it was determined that only one of the two existing diesel sites would be required to meet the combined peak capacity requirements of the communities for the 60 Amp option up to the end of the study period, 2041. However, for the 200 Amp option, both the Brochet and Lac Brochet diesel sites would be required to meet the combined peak capacity requirements and an additional 855 kW diesel generating unit would be required at Lac Brochet by 2028 to ensure capacity adequacy.

While dependable flow is the appropriate criteria for determining the capacity requirements for each option, the use of dependable flow to estimate how often diesel generation will operate produces a significant overestimation of diesel operation because dependable flow conditions do not represent normal operation of the hydro plant. In order to determine how often the diesel generators will operate for both the 60 Amp and 200 Amp options, average flow conditions were assumed. While this assumption may overestimate the water flow available in all cases, it is considered reasonable for this level of analysis. The estimated fuel costs associated with diesel operation were therefore based on average flow conditions. More accurate hydrometric information will be required if this option is selected for further analysis.

It is anticipated that these options would require an Environment Act and Water Power Act Licences and would undergo Federal screening (and possibly greater review), as triggered by fish/fish habitat issues and anticipated federal funding. Fisheries Act Authorizations and Navigable Water Approvals would be required. A major environmental assessment program would be required, particularly in regard to fish and fish habitat. The anticipated licensing schedule is estimated to be 3 to 4 years.

Since the 200 Amp option will allow increased use of electrical services relative to the existing 60 Amp level of service, such as space heating, Manitoba Hydro's 200 Amp service load forecast was utilized in the economic analysis. This forecast assumes greater demand than that assumed in the 60 Amp forecast that is used in the analysis of continued diesel operation and Option 1.

3.3.1a Adequacy of the 60 Amp Service Option

For this option, the small hydro plant can meet the combined energy and capacity requirements for Brochet and Lac Brochet under dependable flow conditions until 2027. From 2028 onward, hydro capacity will not be adequate to meet peak capacity requirements under dependable flow conditions. From 2028 to the end of the study period in 2041, the existing diesel generating station at

Lac Brochet provides adequate capacity to meet peak demand under dependable flow conditions.

Under average flow conditions, diesel generation is not required over the entire study period and the combined energy and capacity requirements of both communities can be satisfied with the small hydro station. Beyond the study period, additional capacity would be required under average flow conditions by 2060 and diesel generation would be required for daily peaking under average conditions by 2073 if 2% growth in demand is assumed.

Therefore, for the 60 Amp small hydro option, diesel generation will be eliminated under average flow conditions but will be required under dependable flow conditions over the study period. However, beyond the study period, the capacity of the small hydro station will not be adequate to meet demand if it continues to grow and other supply options will be required in the long-term to supply 60 Amp service.

3.3.1b Adequacy of the 200A Service Option

For this option, the small hydro plant cannot meet the combined energy and capacity requirements for Brochet and Lac Brochet under dependable flow conditions. The existing diesel generating stations at Brochet and Lac Brochet must be retained to satisfy both energy and peak capacity requirements under dependable flow conditions. In addition, an additional diesel generating unit must be installed at Lac Brochet in 2028 to ensure that demand requirements are satisfied under dependable flow conditions until the end of the study period in 2041.

Under average flow conditions, while there is adequate hydro energy available for all years of the study period, there is not adequate hydro capacity to meet peak demand requirements beginning in 2019. From 2019 until the end of the study period in 2041, diesel generation would be required to meet peak load on a regular basis under average flow conditions.

Therefore, for the 200 Amp small hydro option, the hydro station capacity is not adequate to meet peak capacity demand under both dependable and average flow conditions over the study period.

3.3.2 Incremental Environmental Effects

Local Air Quality Effects – the 60 amp option will result in the virtual elimination of emissions of NOx, SOx, CO, CO2, fine particulate matter, and UHC. associated with diesel generation.under average flow conditions over the study period since only the diesel generating station at Lac Brochet will be retained to provide drought support and would be operated only to maintain operational readiness under average flow conditions. However, beyond the study period, diesel operation may be required to meet peak demand.

The 200 Amp option will result in a significant reduction in emissions of NOx, SOx, CO, CO2, fine particulate matter, and UHC associated with diesel generation under average flow conditions over the study period since diesel generation will only be used to supply peak demand (under average conditions). However, beyond the study period, reliance on diesel generation will continue to increase as will the associated air emissions.

Terrestrial Effects – this option will result in a significant increase in terrestrial effects relative to those associated with the existing diesel generating stations due to the larger footprint of the hydro station and the land used for access roads and transmission lines. In addition to riparian zone effects, a forebay of up to 10 hectares is associated with this option.

Aquatic Effects – the small hydro option will result in no change to the diesel fuel spill potential associated with fuel storage facility operation. In addition, this option result in a significant increase in aquatic effects relative to those associated with the existing diesel generating stations. These include fish passage effects, potential effects to spawning activities, increased water turbidity, and potential spills

During construction, there will be potential for spills and releases to water. There are other potential impacts such as disturbance of fish habitat and spawning areas.

3.3.3 Incremental Climate Change Implications

The 60 amp option will result in a 99.7% reduction in GHG emissions relative to continued diesel-only power generation. Combined CO2 emissions from Brochet and Lac Brochet over the study period are estimated to be 0.001 megatonnes, equivalent to 100 vehicles operating normally for one year.

The 200 amp option will result in an 81% reduction in GHG emissions relative to continued diesel-only power generation. Combined CO2 emissions from Brochet and Lac Brochet over the study period are estimated to be 0.046 megatonnes, equivalent to 6,500 vehicles operating normally for one year.

By reducing diesel fuel requirements, both the 60 amp and 200 amp options will decrease GHG emissions associated with fuel transportation and decrease the fuel transportation risk and fuel supply challenges associated with diesel power generation.

3.3.4 Incremental Socioeconomic Benefits

The construction period associated with small hydro is approximately 3 years and would provide various skilled and unskilled employment opportunities that potentially could be filled by community residents. Incremental operational employment associated with small hydro would be minimal.

The longer construction duration for the small hydro option increases business opportunities for the communities in the areas of access road, camp, security, catering, monitoring and community liaison and administration.

The 200 amp option assumes that conversion of residences and businesses to accept 200 amp service is the burden of customers and creates temporary demand for electrical trade opportunities.

3.3.5 Incremental Economic Analysis

The net present value of 60 Amp and 200 Amp small hydro generation relative to status quo continued diesel generator operation was calculated over 35 years (2006 to 2041) using a real discount rate of 6%. Since the delivered cost of diesel fuel is the dominant cost associated with the operation of diesel generators, the economic analysis were performed using Manitoba Hydro's 2006 delivered diesel fuel price forecast (with an annual forecast price which varies from year to year) and at various constant annual average fuel prices in order to determine the sensitivity of the results to fuel price and to determine the break-even fuel price for the options. Table 5 provides the results of the economic analyses for Brochet and Lac Brochet.

Table 5 – NPV of Small Hydro Options Relative to Continued Diesel Generation

(NPV at 6% real discount rate, 35 year study period, 2006 $CDN)

Delivered Fuel Price ($/Litre)	60 Amp Small Hydro (NPV,2006 $CDN)	200 Amp Small Hydro (NPV,2006 $CDN)
MH 2006 Forecasts	*-$6,440,000*	*-$14,080,000*
$0.80	-$9,130,000	-$16,190,000
$0.90	-$6,350,000	-$13,830,000
$1.00	-$3,570,000	-$11,470,000
$1.10	-$790,000	-$9,110,000
$1.129	$0	-$8,440,000
$1.20	$1,990,000	-$6,750,000
$1.30	$4,780,000	-$4,400,000
$1.40	$7,560,000	-$2,040,000
$1.487	$9,960,000	$0
$1.50	$10,340,000	$320,000

The break-even delivered fuel prices are $1.129 per Litre for the 60 Amp small hydro option and $1.487 per Litre for the 200 Amp small hydro option.

On the basis of Manitoba Hydro's 2006 fuel price forecast, both options result in incremental net costs relative to continued operation of the diesel generating stations at Brochet and Lac Brochet.

3.3.6 Summary

Table 6 summarizes the preliminary analysis of mini hydroelectric generation.

Table 6 – Summary of Option 2 – Small Hydro Power

Aspect	**Performance Relative to Continued Diesel Operation**	
	60 Amp Hydro	**200 Amp Hydro**
Reliance on Diesel Power	Diesel eliminated under average flows and significantly reduced under dependable flows	Diesel generation significantly reduced under both dependable and average flows
Local Air Quality Effects	eliminated under average flows and significantly reduced under dependable flows	significantly reduced under both dependable and average flows
Terrestrial Effects	Significant Increase	Significant Increase
Aquatic Effects	Significant Increase	Significant Increase
Socioeconomic Benefits	Minimal	Minimal
Climate Change Implications	Elimination of GHG emissions & fuel transportation risk under average flows, significant reductions under dependable flows	Significant reduction in GHG emissions & fuel transportation risk under both dependable and average flows
NPV @ Forecast Fuel Prices	-$6,440,000	-$14,080,000
Break-Even Fuel Price	$1.129 per Litre	$1.487 per Litre

3.4 Option 3 – Connection to the Transmission Grid

3.4.1 Overview of Option

This option will eliminate the use of diesel generation in the communities of Brochet and Lac Brochet. In addition, this option would result in an upgrade of the service in these communities from 60 Amp to 200 Amp.

Estimates for constructing and operating transmission service for Brochet and Lac Brochet were provided by Manitoba Hydro's Transmission & Distribution System Planning department in late 2005. These estimates are preliminary and carry a range of uncertainty of +/-50%. Should this option be selected for further analysis in the future, more accurate cost estimates are required.

Connection to the transmission grid would originate in Lynn Lake with a new transmission line from Lynn Lake to Brochet and a new transmission line from Brochet to Lac Brochet. If Tadoule Lake is to be grid connected as well, the connection would originate in Lac Brochet. However, if the transmission option is not implemented for Brochet and Lac Brochet, it will not be available for Tadoule Lake since the cost of constructing a line from Lynn Lake to Tadoule Lake alone would be prohibitive.

The assumed in service date for this option is 2012. This option includes the following major items;

- A new 69 kV transmission station in Lynn Lake
- Upgrades to the existing Lynn Lake Terminal transmission and protection equipment
- 145 km of 138 kV transmission line from Lynn Lake to Brochet
- 80 km of 138 kV transmission line from Brochet to Lac Brochet
- Distribution system upgrades in Brochet and Lake Brochet
- Decommissioning of the diesel sites

Only the costs associated with upgrading the distribution systems from 60 amp to 200 amp service were included in this analysis. Costs associated with upgrading individual residences and business to accept 200 amp service have not been included.

Since this option will allow increased use of electrical services relative to the existing 60 Amp service, such as space heating, Manitoba Hydro's 200 Amp service load forecast was utilized in the economic analysis. This forecast assumes greater demand than that assumed in the 60 Amp forecast that is used in the analysis of Option 1.

It is anticipated that this option would require an Environment Act Licence and Federal screening which would require a minimum of two years to complete.

3.4.2 Incremental Environmental Effects

Local Air Quality Effects – this option will eliminate diesel generation thereby eliminating noise and emissions of NOx, SOx, CO, CO2, fine particulate matter, and UHC associated with diesel generation

Terrestrial Effects – this option will eliminate the diesel fuel spill potential associated with operation of fuel storage facilities. However, this option will result in a significant increase in land use as compared to the existing diesel generating stations. The construction of the transmission lines will result in 225 km of linear development and land will be required to site the new transmission station in Lynn Lake. To a lesser degree, similar effects will be associated with ongoing line maintenance activities.

Environmental effects associated with linear developments are dealt with through proper route selection and mitigation techniques. Residual environmental impacts are not significant and are manageable. During the construction phase, there will be emissions and spill potential associated with the operation of heavy construction equipment. These impacts can also be mitigated through effective management/response programs and staff training.

Aquatic Effects – – the transmission option will eliminate the diesel fuel spill potential associated with fuel storage facility operation. However, there is spill potential associated with ongoing line maintenance activities.

During the construction phase, there will be spill potential associated with the operation of heavy construction equipment and the potential for disruption of riparian zones at water crossings. These impacts can be mitigated through effective management/response programs and staff training.

3.4.3 Incremental Climate Change Implications

This option will eliminate the local GHG emissions associated with diesel power generation. Due to the fact that the community would now be supplied by hydro energy that may have otherwise been exported to the US, there may be no net global reduction in GHG emissions associated with this option since there may be an increase in GHG emissions in the US if increased dispatch of thermal units is required to compensate for reduced imports of hydro power. On a global scale, any change in GHG emissions associated with grid connection would be minimal, although a point source of emissions would be eliminated.

This option will also eliminate the fuel transportation risk and fuel supply challenges associated with diesel power generation.

3.4.4 Incremental Socioeconomic Benefits

The construction period associated with grid connection is approximately 2 years and would provide various skilled and unskilled employment opportunities that potentially could be filled by community residents. However, due to the reduced scope of construction work as compared to the small hydro options, there is much less construction employment potential associated with grid connection. As with the small hydro options, incremental operational employment associated with small hydro would be minimal.

The 200 amp option assumes that conversion of residences and businesses to accept 200 amp service is the burden of customers and creates temporary demand for electrical trade opportunities.

Grid connecting the community would also result in the loss of the local diesel station operator as an employment opportunity.

3.4.5 Incremental Economic Analysis

The net present value of connecting Brochet and Lac Brochet to the transmission grid relative to status quo continued diesel generator operation was calculated over 35 years (2006 to 2041) using a real discount rate of 6%. Since the delivered cost of diesel fuel is the dominant cost associated with the operation of diesel generators, the economic analysis was performed using Manitoba Hydro's 2006 delivered diesel fuel price forecast (with an annual forecast price which varies from year to year) and at various constant annual average fuel prices in order to determine the sensitivity of the results to fuel price and to determine the break-even fuel price for the option.

Based on Manitoba Hydro's 200 amp combined load forecasts for the communities, the present value marginal energy cost to supply the communities from the grid is estimated to be $14,170,000 over the study period assuming a marginal energy cost of $0.056/kWh. However, since this option would see the communities absorbed into the general rate base and eliminate the existing "islanded" cost recovery structure, the incremental NPV of the transmission option was determined with and without the marginal cost of energy to allow comparisons to the “islanded” options with and without consideration of this cost. Table 7 provides the results of the economic analysis excluding the marginal cost of energy and Table 8 provides the results including the marginal cost of energy.

Table 7 – NPV of Connecting Brochet & Lac Brochet to the Transmission Grid Relative to Continued Diesel Generation
Excluding Marginal Cost of Energy

(NPV at 6% real discount rate, 35 year study period, 2006 $CDN)

Delivered Fuel Price ($/Litre)	Grid Connection (NPV,2006 $CDN)
MH 2006 Forecast	*-$22,660,000*
$0.80	-$25,370,000
$0.90	-$22,580,000
$1.00	-$19,790,000
$1.10	-$17,000,000
$1.20	-$14,200,000
$1.30	-$11,410,000
$1.40	-$8,620,000
$1.50	-$5,830,000
$1.60	-$3,040,000
$1.70	-$250,000
$1.709	$0
$1.80	$2,550,000

Table 8 – NPV of Connecting Brochet & Lac Brochet to the Transmission Grid Relative to Continued Diesel Generation
Including Marginal Cost of Energy

(NPV at 6% real discount rate, 35 year study period, 2006 $CDN)

Delivered Fuel Price ($/Litre)	Grid Connection (NPV,2006 $CDN)
MH 2006 Forecast	*-$36,830,000*
$1.00	-$33,960,000
$1.10	-$31,170,000
$1.20	-$28,380,000
$1.30	-$25,590,000
$1.40	-$22,790,000
$1.50	-$20,000,000
$1.60	-$17,210,000
$1.70	-$14,420,000
$1.80	-$11,630,000
$1.90	-$8,840,000
$2.00	-$6,605,000
$2.217	$0

The break-even delivered fuel price for this option is $1.709 per Litre excluding the marginal cost of energy and $2.217 per Litre when the marginal cost of energy is included.

On the basis of Manitoba Hydro's 2006 fuel price forecast, this option is a net cost relative to continued operation of the diesel generating stations at Brochet and Lac Brochet.

3.4.6 Summary

Table 9 summarizes the preliminary analysis of connection to the transmission grid.

Table 9 – Summary of Option 3 – Connection to the Transmission Grid

Aspect	Performance Relative to Continued Diesel Operation
Reliance on Diesel Power	Eliminate
Local Air Quality Effects	Eliminated
Terrestrial Effects	Significant Increase
Aquatic Effects	Significant potential decrease as it eliminates potential for diesel fuel spills
Socioeconomic Benefits	Minimal
Climate Change Implications	Eliminates local GHG emissions & fuel transportation risk. May not result in near term global GHG emissions
NPV @ Forecast Fuel Prices Excluding marginal energy cost	-$22,660,000
Break-Even Fuel Price Excluding marginal energy cost	$1.709 per Litre
NPV @ Forecast Fuel Prices Including marginal energy cost	-$36,830,000
Break-Even Fuel Price Including marginal energy cost	$2.217 per Litre

4.0 Home Heating Cost Implications of 200 Amp Service Options

Supply options which offer the potential to upgrade from 60A to 200A service create the opportunity for residential customers to convert from current heating systems which use fuel oil to electric baseboard heating systems. The average annual energy requirement for residential heat per household for Brochet and Lac Brochet is estimated to be 25,000 kWh and 26,000 kWh, respectively (compared to 15,000 to 16,000 kWh in southern Manitoba). The fuel cost, at current prices, to meet this heat load with oil and electric heating systems are shown in Table 10 below. These values do not include operating and maintenance or heating system conversion costs.

Table 10 – Estimated 2006 Annual Residential Heating Fuel Costs (2006 $CDN)

Fuel	Heating System	Efficiency	Brochet	Lac Brochet
Oil	Vented Space Heater	60%	$3,900	$4,300
Oil	Forced Air Furnace	60 to 89%	$3,900 to $2,600	$4,300 to $2,900
Electric	Baseboard	95%	$1,500	$1,500

Appendix A - Technical & Environmental Screening of Potential Supply Options

A screening exercise was utilized to identify potential options for preliminary analysis. This appendix provides an explanation of the screening criteria and the results of the screening exercise.

Potential supply options were restricted to those that either reduce or eliminate the use of diesel-fired generation. Therefore, options such as small simple cycle aeroderivative gas turbine generators, which would have to burn diesel fuel in a remote location, were not considered as they do not meet this objective.

The option of upgrading the existing diesel generators to supply 200 Amp service was considered. The main driver for upgrading the service in these communities from 60 Amps to 200 Amps is the use of electricity for residential space heating. If electricity for residential heating is supplied by diesel generators, the efficiency of the conversion of diesel energy to electricity is approximately 34% and the conversion efficiency of electricity to heat is approximately 95% for a total diesel-to-heat conversion efficiency of 34% X 95% = 32%. If diesel fuel is burned directly to provide heat for a residence, the diesel-to-heat conversion efficiency is in the range of 60% to 89% depending on the type of liquid fuel furnace that is used. Therefore, for the purpose of residential heating, burning diesel directly to produce heat is 1.9 to 2.8 times more efficient than burning diesel to produce electricity which is then used to produce heat. The use of diesel generators to supply 200 Amp service would therefore result in a significant increase in diesel consumption and associated emissions relative to 60 Amp operation and this option was therefore screened out for further evaluation as it does not meet the objective of reducing or eliminating the use of diesel-fired generation in Brochet and Lac Brochet.

Once options such as these are eliminated, there are still many potential supply options that meet the simple criterion of reducing or eliminating diesel-fired generation. In order to determine the options that merit further study for this application, a technical and environmental screening exercise was conducted. This Appendix summarizes the screening exercise.

Supply options that met the objective of either reducing or eliminating diesel generation were then assessed on the basis of 5 parameters relative to existing diesel-fired generators;

- *State of Technological Development* – Is the technology commercially available and proven? The existing diesel generators are a proven, mature technology.
- *Reliability & Maintainability* – Will the option perform reliably in severe cold weather conditions and can the option be maintained in a remote location?

From Manitoba Hydro's perspective, one of the primary considerations in evaluating power supply options for remote communities is reliability. Reciprocating diesel generating units have historically been chosen to supply remote, off-grid communities because of their proven high reliability and simple maintenance requirements relative to more complex thermal generation options such as steam turbine plants. For this reason, alternative supply options were evaluated relative to the performance of diesel generators to ensure that any new supply option chosen for analysis would not compromise the reliability of service in these remote communities.

- *Dispatchability* – Can the option be dispatched to meet demand? The existing diesel generators can be dispatched to meet changes in demand as required.
- *Environmental Effects* – What are the major environmental effects associated with the option? The existing diesel generators produce emissions of NOx, SOx, CO, CO2, fine particulate matter, and unburned hydrocarbons (UHC). Aquatic effects include groundwater contamination due to fuel spills and the risk of spills during fuel transportation over winter roads.
- *Fuel Supply* – What are the fuel supply availability, transportation, storage, and handling issues associated with the option? The existing diesel generators have certainty of fuel supply availability, but significant transportation challenges associated with use of winter roads and spill and soil contamination risks associated with fuel storage and handling.

Options with equivalent or superior performance over these five parameters relative to the existing diesel generators were selected for further analysis.

The results of the technical and environmental screening exercise are presented in Table A1 below.

Table A1 – Technical & Environmental Screening Results

Option	State of Technological Development	Reliability & Maintainability	Dispatchability	Environmental Effects	Fuel Supply	Acceptable?
Solar Photovoltaics	Commercially available, mature. However, not yet considered practical for large scale applications.	Unproven in these service conditions	Not dispatchable. Must be used in combination with a dispatchable supply option.	**Terrestrial** large footprint **Air Quality** N/A **Aquatics** N/A **Noise** N/A	Not applicable	No
Hydrogen Based Thermal Generation (reciprocating gensets fired with hydrogen)	Research & Development	Unproven, but assumed to be similar to existing diesel gensets (~95% plant availability)	Dispatchable	**Terrestrial** small footprint **Air Quality** not significant **Aquatics** not significant **Noise** constant process noise	Significant challenges associated with fuel supply, transportation, storage, and handling.	No
Biomass Based Thermal Generation (boiler and steam turbine for power generation)	Commercially available, immature.	Reliability assumed to be similar to coal fired generation (~85% plant availability). Significant challenges associated with ensuring adequate on site technical expertise, part supply, and support staff. Significant challenges associated with access to OEM and contract expertise.	Dispatchable	**Terrestrial** medium footprint, land use reqiuired for storage of ash **Air Quality** emissions of NOx , SOx, and particulate matter, but assumed to be CO2 neutral **Aquatics** water withdrawal for process steam and cooling, potential liquid effluent depending on ash handling process, possible groundwater contamination risk and risk of spills during fuel transportation **Noise** constant process noise.	Uncertainty associated with supply availability. Backup fuel supply, such as diesel would be required to ensure adequate supply is available at all times. Significant transportation challenges associated with use of winter roads, significant storage and handling challenges in extreme cold service conditions.	No
Wind Generation	Commercially available, mature.	see GEC report for Alaska experience	Not dispatchable. Must be used in combination with a dispatchable supply option.	**Terrestrial** medium footprint, potential for bird strikes and disruption to wildlife due to noise **Air Quality** N/A **Aquatics** N/A **Noise** Minor process noise	Unknown. Wind resource data required.	Yes

Table A1 (con't) – Technical & Environmental Screening Results

Option	State of Technological Development	Reliability & Maintainability	Dispatchability	Environmental Effects	Fuel Supply	Acceptable?
Small Hydro Generation	Commercially available, mature	~95% Plant availability , proven maintainability in these service conditions	Dispatchable	**Terrestrial** large footprint **Air Quality** N/A **Aquatics** oil spill potential, turbidity potential, fish effects **Noise** constant process noise	Minimal water storage, supply subject to local stream flows and levels.	Yes
Connection to Transmission Grid	Commercially available, mature	~95% availability, proven maintainability in these service conditions	Dispatchable	**Terrestrial** large footprint **Air Quality** N/A **Aquatics** N/A **Noise** N/A	Not applicable	Yes
Existing Diesel Generators	Commercially available, mature	~95% Plant availability , proven maintainability in these service conditions	Dispatchable	**Terrestrial** small footprint **Air Quality** emissions of NOx, SOx, CO, CO2, fine particulate matter, and unburned hydrocarbons (UHC) **Aquatics** no water withdrawal or effluent streams, possible groundwater contamination risk, risk of spills during fuel transportation **Noise** constant process noise.	Good supply availability, significant transportation challenges associated with use of winter roads, spill and soil contamination risks with storage and handling.	N/A

Based on the screening exercise, the following options were excluded from further consideration;

- *Solar photovoltaics* – this option was excluded because it is not yet considered practical for large scale applications, has unproven reliability and maintainability in extreme cold weather service conditions, and is not dispatchable. The current technology has a very low annual capacity factor (~8%). This would pose significant challenges to integrating this technology with the existing diesel generators while ensuring reliability of service. However, this option could be considered as a possible option for individuals to reduce residential electricity demand.
- *Hydrogen-Based Thermal Generation* – this option was excluded because it is still in the R&D phase of technological development and has significant uncertainty and challenges associated with the supply, transportation, storage, and handling of hydrogen in severe service applications.
- *Biomass-Based Thermal Generation* – this option was excluded on the basis of its greater air and aquatic effects relative to existing diesel generation, the significant challenges associated with the handling and storage of ash, and the significant maintenance challenges associated with operating a steam power plant in a remote location without year-round road access. Fuel supply is also a concern as there is not a sustainable local feedstock available, and there are significant challenges associated with long distance fuel transportation, long term storage, and fuel handling. However, the use of biomass fuel could be considered as a possible option to replace fuel oil for home heating.

The options that were selected for further analysis are as follows;

- *Augmenting Diesel Generation with Wind Power.* This option can only reduce, not eliminate, diesel generation because it is not dispatchable and must therefore be used in combination with existing diesel generators to ensure a continuous, reliable supply of power.
- *Small Hydroelectric Generation.* This option would only use the diesel generation for backup during maintenance outages and low flow periods and would therefore significantly reduce but not eliminate diesel generation. Of the three options evaluated, this option has the greatest environmental effects relative to continued operation of the diesel generators.
- *Connection to the Transmission Grid.* This option has the ability to completely eliminate diesel generation at Brochet and Lac Brochet.

Appendix B - Summary of Assumptions

General Assumptions

- 6% real discount rate
- 2006 to 2041 study period (35 years)
- all costs in constant 2006 $CDN
- 2006 Manitoba Hydro 20 year delivered diesel price forecast for fiscal years 2006 to 2026. For the period beyond the forecast, 2027 to 2041, prices were held constant at their 2026 forecast values.
- 2.73 tonnes of CO2 are produced for each tonne of diesel burned

Load Forecast Growth Assumptions

Brochet

- 116 residential customers in 2006
    - residential growth of 2 houses per year assumed for both 60 amp and 200 amp service
- 42 general service customers in 2006
    - general service growth of 1 customer per year assumed for both 60 amp and 200 amp service

Lac Brochet

- 137 residential customers in 2006
    - residential growth of 3 houses per year assumed for both 60 amp and 200 amp service
- 46 general service customers in 2006
    - general service growth of 1 customer per year assumed for both 60 amp and 200 amp service

These assumptions apply to Manitoba Hydro's 2006 20 year load forecasts for 60 amp and 200 amp service (2006 to 2026). For the period beyond the forecast, 2027 to 2041, load growth of 2% per year was assumed for 60 amp service and load growth of 1% per year was assumed for 200 amp service. These percentage growth assumptions are based on average growth rates during the 2006 to 2026 forecast period.

Existing Diesel Generating Station Assumptions

Diesel Generator Replacement Cost

- $594 per kW, includes switchgear and installation
- based on Nov 2004 AMD Reciprocating Engine Power Services Process Review Final Report, AMD report no. AMD 2004-02

New Diesel Generator Capital Cost

- $891 per kW
- assumed new unit cost is 50% greater than replacement cost on a per kW basis

Non-Fuel Operating and Maintenance Cost

- $290,177 per year for Brochet
- $353,122 per year for Lac Brochet
- both based on 5 year average Manitoba Hydro SAP O&M order settlements

Diesel Generator Service Life

- 14 years
- based on the 2004/05 AMD North Diesel Generating Stations Report

Diesel Generator Thermal Efficiency

- 3.7 kWh per litre of diesel for Brochet and Lac Brochet
- based on the 2004/05 AMD North Diesel Generating Stations Report

Diesel Site Decommissioning Cost

- $3.0 million per site
- RPMA estimate based on thermal station decommissioning cost estimates

Wind Generation Assumptions

Wind Turbine Model

- Fuhrländer FL250
- 50 m tower height
- 29.5 m rotor diameter
- Based on the July 2006 Global Energy Concepts (GEC) report *Preliminary Analysis of Wind-Diesel Opportunities in Remote Manitoba Communities*

Wind Energy Penetration Rate

- 20% of annual energy demand
- Based on the July 2006 Global Energy Concepts (GEC) report *Preliminary Analysis of Wind-Diesel Opportunities in Remote Manitoba Communities*

In Service Dates

- Brochet – two turbines in 2012, a third turbine in 2020, and a fourth turbine in 2036
- Lac Brochet – three turbines in 2012 and a fourth turbine in 2027.

Capital Cost

- $3335 per kW
- Based on the July 2006 Global Energy Concepts (GEC) report *Preliminary Analysis of Wind-Diesel Opportunities in Remote Manitoba Communities*
- Assumed GEC cost estimate plus 15% to account for access roads and transmission lines.

Operating & Maintenance Cost

- $28.75 per kW
- Based on the July 2006 Global Energy Concepts (GEC) report *Preliminary Analysis of Wind-Diesel Opportunities in Remote Manitoba Communities*
- Assumed GEC cost estimate plus 15% to account for additional challenges associated with remote maintenance.

Turbine Service Life

- 25 years
- consistent with Manitoba Hydro wind evaluation methodology

Regulatory Process Cost & Duration

- $250,000, internal process cost estimate
- process time less than one year

Small Hydro Generation Assumptions

In Service Date: 2012

Capital Costs (Manitoba Hydro estimates)

- Generating station = $37.6 million
- Transmission = $4.12 million (60 amp), $6.94 million (200 amp)

Operating & Maintenance Costs (Manitoba Hydro estimates)

- Generating station = $661,250 per year
- Transmission = $48,517 per year

Hydrometric Assumptions

- Dependable flow = 55 m^3/s
- Average flow = 149 m^3/s
- Hydraulic head = 5.5 m
- Hydro turbine efficiency = 88%

Generating Station and Transmission Service Lives

- Generating station = 67 years
- Transmission station = 35 years
- Transmission line = 50 years
- Consistent with Manitoba Hydro evaluation methodology

Regulatory Process Cost & Duration

- $5.0 million
- 4 year duration

138 kV Transmission Assumptions

In Service Date: 2012

Capital Costs (based on 2005 Manitoba Hydro estimates)

- Transmission station = $22.61 million
- Transmission line = $45.90 million

Operating & Maintenance Costs (Manitoba Hydro estimates)

- Transmission station = $35,733 per year
- Transmission line = $191,767 per year
- Marginal cost of energy = $0.056/kWh assuming load is served from northern generation

Transmission Service Lives

- Transmission station = 35 years
- Transmission line = 50 years
- Consistent with Manitoba Hydro evaluation methodology

Transmission Line Distances (Manitoba Hydro estimates)

- Lynn Lake to Brochet = 145 km
- Brochet to Lac Brochet = 80 km

Regulatory Process Cost & Duration

- $1.4 million
- 2 year duration

Residential Heating Assumptions

N.E.M.A. formula inputs

- Heat Loss = 11.44
    - value for a 1000 sq. ft. bungalow with an unheated crawlspace
    - includes a 10% add-on for locations north of the 53rd parallel
- Constant = 14
    - Average for most homes
- Brochet Degree Days = 8492
  Lac Brochet Degree Days = 9047
    - Based on geographic location and indoor design temperature of 22°C
- Design Temperature Difference = 55°C
- Formula inputs based on values obtained from Manitoba Hydro's "Efficient Heating of Buildings Manual".

Oil Heating Systems

- Energy per litre of oil = 10.611 kWh
    - Based on 38.2 MJ/litre obtained from "Heating with Oil", available from Natural Resources Canada
- Vented space heater efficiency = 60%
- Forced air furnace efficiency range = 60 to 89%
    - Range covers a variety of potential furnace installations
- Fuel Oil heating efficiencies based on values obtained from "Heating with Oil", available from Natural Resources Canada
- Brochet 2006 Fuel Oil price = $0.99
  Lac Brochet 2006 Fuel Oil Price = $1.06
- 2006 Fuel Oil Prices based on 2006 Manitoba Hydro 20 year delivered diesel price forecast for fiscal years 2006 to 2026

Electric Baseboard Heating

- Residential Rate Energy Charge = $0.05654
- Based on information obtained from Manitoba Hydro's Customer Policy Application Website

MANITOBA HYDRO

GENERATING RESOURCE SCREENING STUDY

SYNOPSIS:	Preliminary analysis of potential centralized supply options that may reduce or eliminate 60 Amp diesel-fired generation in non grid-connected communities.
LOCATION:	Tadoule Lake
DATE:	October 2007
FINALIZED:	November 2008

PROVINCE OF MANITOBA
B. E.
JOHNSON
Member
24023
[illegible]
REGISTERED PROFESSIONAL ENGINEER

Executive Summary

As part of its ongoing planning activities and in response to requests from various stakeholders, Manitoba Hydro performed a preliminary analysis of potential alternatives to diesel-fired power generation for the community of Tadoule Lake. This analysis is intended to provide preliminary information to determine if more detailed analysis of a particular option is warranted.

Based on a technical and environmental screening process that considered several alternatives, two options were chosen for preliminary analysis; wind power and connection to the Manitoba transmission grid. Wind power must be used in conjunction with the existing diesel station and is therefore limited to 60 amp service. Connection to the transmission grid enables 200 amp service.

The environmental, socioeconomic, and cost characteristics associated with each option were analyzed relative to continued operation of the diesel generating station in order to allow incremental comparisons of the alternative supply options to ongoing diesel operation. The economic analyses of the options are presented in terms of the net present value of each option relative to continued operation of the diesel station and in terms of "break-even" fuel price. The break-even fuel price represents the fuel price at which the cost of continued operation of the diesel station is equivalent to the estimated cost of the option under evaluation, resulting in a net present value of zero. For comparative purposes, the average annual delivered fuel price associated with Manitoba Hydro's 2006 price forecasts is \$0.97 per Litre at Tadoule Lake.

The incremental capital and operating costs associated with each option have been evaluated without consideration for which party would be responsible for incurring these costs. A more detailed analysis would take this into consideration and Manitoba Hydro would require contributions from the benefiting parties prior to undertaking any capital expenditures associated with the installation of new generation options.

Table 1 summarizes the results of the analysis of the 60 amp option relative to continued operation of the existing diesel generators.

Table 1 – Summary of Preliminary Analysis of 60 Amp Option Performance Relative to Continued Diesel Operation
(NPV at 6% real discount rate, 35 year study period, 2006 $CDN)

Aspect	Wind Power Augmentation Tadoule Lake (60 amp)
Reliance on Diesel Power	Minor Reduction
Local Air Quality Effects	Minor Reduction
Terrestrial Effects	Minor increase
Aquatic Effects	No Change
Socioeconomic Benefits	Minimal
Climate Change Implications	Minor GHG Reductions
Incremental NPV @ Forecast Fuel Prices (2006 $CDN)	$1,340,000
Break-Even Fuel Price ($ per Litre) Based on continued operation of 60 Amp diesel stations	$0.603
Total Capital Cost Over Study Period (2006 $ CDN)	$5,000,000

It must be noted that the annual wind energy assumed in this evaluation is now considered optimistic for a low-penetration option. The 20% annual energy assumption was made based on information available at the time. The level of achievable instantaneous capacity penetration is another limiting factor that will need to be investigated and addressed if this option is identified for further study. Manitoba Hydro is currently evaluating potential wind penetration levels further for the remote diesel communities based on both instantaneous capacity and annual energy penetration criteria. Should these evaluations indicate that achievable penetration levels are lower than those assumed in this study, the resulting reductions in diesel generation are expected to result in reduced economic benefits for the wind/diesel option.

As for the 60 Amp option, the net present value of the 200 amp option is incremental to continued 60 amp diesel operation. The analysis of the 200 amp option does not include the costs associated with conversion of individual residences to accept 200 amp service or the cost savings associated with switching to electricity for home heating.

For the transmission connection option, the present value marginal cost of the energy required to supply the forecast 200 Amp demand for the community is estimated to be $6,340,000 over the study period assuming a marginal cost of $0.056/kWh. However, since this option would see the communities absorbed into the general rate base and eliminate the existing "islanded" cost recovery structure, the incremental NPV of the transmission option is provided with and without the marginal cost of energy to allow comparisons to the "islanded" options with and without consideration of this cost. Table 2 summarizes the results of the analysis of the 200 amp option.

Table 2 – Summary of Preliminary Analysis of 200 Amp Option Performance Relative to Continued Diesel Operation

(NPV at 6% real discount rate, 35 year study period, 2006 $CDN)

Aspect	Transmission Connection (200 amp)
Reliance on Diesel Power	Eliminate
Local Air Quality Effects	Eliminate
Terrestrial Effects	Significant Increase
Aquatic Effects	Significant potential decrease as it eliminates potential for diesel fuel spills
Socioeconomic Benefits	Minimal
Climate Change Implications	Local GHG emissions eliminated. May not decrease near-term global GHG emissions.
Incremental NPV @ Forecast Fuel Prices (2006 $CDN)	-$23,070,000 (excluding marginal energy cost) -$29,410,000 (including marginal energy cost)
Break-Even Fuel Price ($ per Litre) Based on continued operation of 60 Amp diesel station	$2.539 (excluding marginal energy cost) $2.973 (including marginal energy cost)
Total Capital Cost Over Study Period (2006 $ CDN)	$49,070,000

Connection to the transmission grid is the only option that eliminates diesel generation and provides 200 amp service. The wind power option results in a reduction in diesel generation, however a more detailed study using site-specific wind resource data is required before an accurate determination of wind generation potential can be made. The incremental socioeconomic benefits associated with all options are minimal, with construction activities providing the majority of the benefits in all cases.

The assumed routing of the transmission line is from Lynn Lake to Brochet and then from Brochet to Lac Brochet. If Tadoule Lake is also to be connected to the grid, the connection would originate in Lac Brochet. However, if the transmission option is not implemented for Brochet and Lac Brochet, it will likely not be available for Tadoule Lake since the cost of constructing a line from Lynn Lake to Tadoule Lake alone would be prohibitive.

This preliminary analysis is intended to provide only comparative indications of the attractiveness of the supply options relative to continued operation of the diesel generating station. Should one or more of the options be selected as potential candidates for further consideration, more rigorous environmental, socioeconomic, and economic evaluations will be required for decision-making purposes.

EXECUTIVE SUMMARY i

1.0 INTRODUCTION 1

2.0 TECHNICAL & ENVIRONMENTAL SCREENING OF POTENTIAL SUPPLY OPTIONS 3

3.0 PRELIMINARY ANALYSIS OF SELECTED SUPPLY OPTIONS 5

3.1 Current State – Continued Operation of Diesel Generating Stations 5
3.1.1 Overview of Option 5
3.1.2 Environmental Effects 6
3.1.3 Climate Change Implications 6
3.1.4 Socioeconomic Benefits 7
3.1.5 Cost Analysis 7

3.2 Option 1 – Augmenting Diesel Generation with Wind Power 8
3.2.1 Overview of Option 8
3.2.2 Incremental Environmental Effects 9
3.2.3 Incremental Climate Change Implications 10
3.2.4 Incremental Socioeconomic Benefits 10
3.2.5 Incremental Economic Analysis 10
3.2.6 Summary 12

3.3 Option 2 – Connection to the Transmission Grid 13
3.3.1 Overview of Option 13
3.3.2 Incremental Environmental Effects 14
3.3.3 Incremental Climate Change Implications 14
3.3.4 Incremental Socioeconomic Benefits 15
3.3.5 Incremental Economic Analysis 15
3.3.6 Summary 17

4.0 HOME HEATING COST IMPLICATIONS OF 200 AMP SERVICE OPTION 18

APPENDIX A - TECHNICAL & ENVIRONMENTAL SCREENING OF POTENTIAL SUPPLY OPTIONS A-1

APPENDIX B - SUMMARY OF ASSUMPTIONS B-1

1.0 Introduction

Manitoba Hydro operates reciprocating diesel generating units to supply power to the remote communities of Brochet, Lac Brochet, Shamattawa, and Tadoule Lake. This report summarizes the preliminary analysis of several potential supply alternatives for the community of Tadoule Lake.

While there are no operational or reliability concerns associated with the existing diesel generating station at Tadoule Lake, Manitoba Hydro regularly evaluates opportunities to improve the performance of these assets. In addition, the PUB, Indian and Northern Affairs Canada (INAC), MKO, the Government of Manitoba, and other stakeholders have expressed interest in reducing or eliminating the use of diesel for power generation at these sites and in reducing the cost of service in off-grid communities.

The scope of this preliminary analysis includes the following;

- Identification of potential non-fossil fuel burning centralized power generation technologies that may be used to either reduce or eliminate continued diesel generation in the community of Tadoule Lake
- Connection to the transmission grid
- Analysis of the environmental effects, social effects, and costs associated with potential alternative power generation resources
- Identification and analysis of resource options that provide 200 amp service

The scope of this analysis does not include;

- Analysis of distributed power generation options, such as solar panels
- Analysis of demand side management opportunities available to the community as these were assumed to affect all potential supply options equally
- Analysis of combined heat and power applications
- Detailed analysis of home heating options and associated costs available to individual residences and businesses
- Analysis of the costs that individual residences and business may incur to upgrade to 200 amp service
- Soil remediation costs. Only diesel site decommissioning costs were considered

These analyses are preliminary in nature and are intended to provide only comparative indications of the attractiveness of the supply options relative to continued operation of the diesel generating station. Should one or more of the options be selected as potential candidates for further consideration, more rigorous environmental, socioeconomic, and economic evaluations will be required for decision-making purposes.

2.0 Technical & Environmental Screening of Potential Supply Options

Potential supply options were restricted to those that either reduce or eliminate the use of diesel-fired generation. The options that met this objective were then assessed on the basis of the following 5 parameters in order to identify those options that are appropriate for this application;

- State of Technological Development – is the technology commercially available and proven?
- Reliability & Maintainability – will the option perform reliably in severe cold weather conditions and can the option be maintained in a remote location with limited road access?
- Dispatchability – can the option be dispatched to meet demand?
- Fuel Supply – what are the fuel supply availability, transportation, storage, and handling issues associated with the option?
- Environmental Effects – what are the major environmental effects on land, air, and water associated with the option?

Appendix A provides a summary of the results of the technical and environmental screening exercise. The options selected for preliminary analysis based on this exercise are as follows;

- *Option 1 – Augmenting Diesel Generation with Wind Power.* This option will reduce diesel generation. Replacement is not feasible because wind is not dispatchable and must therefore be used in combination with other sources of dispatchable power. This analysis assumes that wind will be used in combination with the existing diesel generators to ensure a continuous, reliable supply of power.
- *Option 2 – Connection to the Transmission Grid.* This option has the ability to completely eliminate the requirement for diesel generation at Tadoule Lake.

The option of supplying 200 Amp service with diesel generators was considered but was screened out. The main driver for increasing service from 60 Amps to 200 Amps in the community of Tadoule Lake is the use of electricity for residential space heating. However, using diesel to heat a home directly with a liquid fuel furnace is approximately 1.9 to 2.8 times more efficient than using diesel to generate electricity which is then used to heat a home with resistive heaters. Therefore, the use of diesel generators to supply 200 Amp service to supply additional electricity for residential space heating would result in a significant increase in diesel consumption and associated emissions relative to 60 Amp operation. This option was therefore screened out for further evaluation as it does not meet the objective of reducing or eliminating the use of diesel-fired generation.

3.0 Preliminary Analysis of Selected Supply Options

The two supply options were evaluated on the basis of their environmental, social, and cost characteristics relative to continued operation of the diesel generating station at Tadoule Lake. In addition, the climate change implications of the options are discussed.

The existing diesel generating station in Tadoule Lake is assumed to continue normal operation until each option is fully installed and operational. Given the varying construction and regulatory lead times associated with the options, the assumed in service dates may be delayed based on the timing of a decision to commit to a particular option.

The economic analyses of the options are presented in terms of the net present value of each option relative to continued operation of the diesel station and in terms of "break-even" fuel price. The break-even fuel price represents the fuel price at which the cost of continued operation of the diesel station is equivalent to the estimated cost of the option under evaluation, resulting in a net present value of zero.

Manitoba Hydro's intention is to share this screening study with the community, their representatives and INAC for their review, comment and further discussion. As Manitoba Hydro's policy with respect to service extension is that the customer or customer group requesting or benefiting from the provision of service must pay for the service, discussions regarding funding and commitments must be in place prior to progressing to the next stage of detailed evaluation and design.

3.1 Current State – Continued Operation of Diesel Generating Stations

3.1.1 Overview of Option

The diesel generating station at Tadoule Lake includes three 425 kW units and one 855 kW unit for a station total capacity of 2,130 kW. Additional reciprocating diesel generating units will be added at the station to meet increases in electrical demand over time.

The diesel generators installed at the station have thermal efficiencies of approximately 31% which is on par with current reciprocating diesel engine technology. Future improvements in diesel engine technology may provide opportunity to install more thermally efficient units as existing units reach the end of their service lives, but thermal efficiency improvements are not currently anticipated to be significant as diesel engine technology is mature with little significant research and development taking place.

Potential soil remediation costs associated with past, present, or future operation of the diesel site have not been included in this analysis.

3.1.2 Environmental Effects

Local Air Quality Effects – operation of diesel generators results in emissions of NOx, SOx, CO, CO2, fine particulate matter, and unburned hydrocarbons (UHC). In addition, diesel generators produce constant process noise.

Terrestrial Effects – operation of diesel generators requires land use for the generating station, the fuel storage tank farm, access roads to the station and tank farm, and the transmission lines from the station. Diesel fuel spill potential is associated with the operation of the fuel storage facility and associated piping which can result in soil, surface, and ground water contamination. There is also spill potential associated with fuel transportation.

Aquatic Effects – operation of diesel generators does not require water withdrawal and involves no liquid effluent streams. The greatest risk to aquatic life occurs during the diesel truck haul over the winter road system and the ever present potential of vehicle and load loss due to bad ice conditions.

3.1.3 Climate Change Implications

Over the study period from 2007 to 2042, CO2 emissions associated with operation of the Tadoule Lake diesel generating station will total approximately 0.13 megatonnes based on Manitoba Hydro's 2006 load forecasts. This is equivalent to 18,000 vehicles operating normally for one year. This translates to an annual average of 3,600 tonnes, which is equivalent to 500 vehicles operating normally for one year, or approximately 0.018% of Manitoba's total annual GHG emissions.

One of the potential effects of climate change is increased and more extreme ambient temperature variability. This poses fuel transportation risk due to potential decreases in the duration of the winter road season. In addition, potential challenges to maintaining adequate on site fuel supplies will be associated with increased and more extreme temperature variability.

3.1.4 Socioeconomic Benefits

One plant operator is employed in the community and maintenance activities provide contract employment to local residents. In addition, the community receives an economic benefit of approximately $0.03/L from the diesel fuel that is consumed for power generation.

3.1.5 Cost Analysis

The present value cost of continued operation of the diesel generating station at Tadoule Lake was calculated over 35 years (2007 to 2042) using a real discount rate of 6%. Since the delivered cost of diesel fuel is the dominant cost associated with the operation of diesel generators, the economic analyses were performed using Manitoba Hydro's 2006 delivered diesel fuel price forecasts for the community (with delivered prices that vary from year to year) and at various constant annual fuel prices in order to determine the sensitivity of the results to fuel price. The delivered fuel price forecasts differ for each community due to differences in transportation costs. Costs associated with air emissions have not been included in these analyses. Table 1 provides the results of the present value cost analysis for Tadoule Lake.

Table 1 – Present Value Cost of Continued Diesel Generation at Tadoule Lake

Delivered Fuel Price ($/Litre)	**Tadoule Lake (PV,2006 $CDN)**
MH 2006 Tadoule Lake Price Forecast	*$24,570,000*
$0.70	$19,400,000
$0.80	$21,370,000
$0. 90	$23,330,000
$1.00	$25,290,000
$1.10	$27,260,000

The average annual delivered fuel prices associated with Manitoba Hydro's 2006 price forecasts are $0.97 per Litre at Tadoule Lake.

3.2 Option 1 – Augmenting Diesel Generation with Wind Power

3.2.1 Overview of Option

Wind generation is not dispatchable to meet demand and therefore must be used in combination with the existing diesel generators at Tadoule Lake to ensure a continuous, reliable supply of power to the community. This option will decrease, but will not eliminate the use of diesel generation. In addition, since this option works in combination with the existing diesel generators, the community would continue to be provided with 60 Amp service.

In order to determine the feasibility of installing wind generation in combination with existing diesel generators, Manitoba Hydro retained Global Energy Concepts, LLC (GEC) in 2006 to conduct preliminary feasibility studies for the communities of Brochet, Lac Brochet, Tadoule Lake, and Shamattawa. The recommendations and results of GEC's study formed the basis of Manitoba Hydro's preliminary analysis of the use of wind power in Tadoule Lake.

Since no site-specific wind resource data were available, GEC utilized data from the *Canadian Wind Energy* Atlas and Environment Canada to estimate the wind resource potential for Tadoule Lake. Site-specific wind data will be required if this option is selected for more detailed analysis. While a wind monitoring program has been implemented, the data has not yet been made available to Manitoba Hydro.

GEC recommends that wind energy installations in the off-grid communities be initially limited to 20% of annual energy demand (20% penetration) until sufficient operating experience is gained with the operation of wind-diesel systems. Alaskan communities that operate wind-diesel systems have found this level of penetration compatible with existing diesel generators without requiring costly and sophisticated controls and voltage stability equipment. For these reasons, Manitoba Hydro based its analysis of the wind-diesel option on a penetration level of 20% in the community.

It must be noted that the annual wind energy assumed in this evaluation is now considered optimistic for a low-penetration option. The 20% annual energy assumption was made based on information available at the time. The level of achievable instantaneous capacity penetration is another limiting factor that will need to be investigated and addressed if this option is identified for further study. Manitoba Hydro is currently evaluating potential wind penetration levels further for the remote diesel communities based on both instantaneous capacity and annual energy penetration criteria. Should these evaluations indicate that achievable penetration levels are lower than those assumed in this study, the resulting reductions in diesel generation are expected to result in reduced economic benefits for the wind/diesel option.

The wind turbine assumed in this analysis is the Fuhrländer FL250. This is a 250 kW wind turbine with a tower height of 42 m that can operate in ambient temperatures as low as -40°C. Fuhrländer is designing a tilt-up tower for this model which does not require a crane for erection. Since the tower design is not commercially available, GEC estimated the capital cost of the unit based on the use of custom-designed towers. The capital cost estimate has a range of uncertainty of -10% to +30%. For this analysis, Manitoba Hydro assumed the GEC capital cost estimate plus 15% to account for transmission equipment and the construction of access roads to the wind turbines

Wind turbines would be located at the site to operate in combination with the existing diesel generators. Wind turbines would be added as energy demand grows to maintain the 20% penetration target. At Tadoule Lake, turbines are assumed to be installed as follows; two turbines in 2013, a third turbine in 2019, and a fourth turbine in 2035.

It is anticipated that this option would not require an Environment Act Licence or Federal screening and would be subject only to Provincial review which would require a maximum of one year to complete.

3.2.2 Incremental Environmental Effects

Local Air Quality Effects – this option will result in a net reduction in emissions of NOx, SOx, CO, CO2, fine particulate matter, and UHC. associated with diesel generation. Since a penetration level of 20% is assumed in this analysis, it can reasonably be assumed that a similar annual decrease in these emissions would be associated with this option.

Terrestrial Effects – this option will result in a net increase in the land use associated with power generation as additional land will be required for the erection of wind turbines, access roads to the turbines, and transmission lines from the turbines. Construction phase terrestrial effects are expected to be minimal.

Although recent studies have shown that wind turbine effects on birds are decreasing, there is still the potential for bird strikes. To minimize potential adverse impacts siting of wind turbines should be outside the main bird migration routes. There are no known bird species at risk as defined by the federal Species at Risk Act or the provincial Manitoba Endangered Species Act in the project area. Noise caused by movement of the blades can also cause disruption to wildlife.

Aquatic Effects – this option will result in no change to the aquatic effects associated with diesel generation. Construction phase aquatic effects are expected to be minimal.

3.2.3 Incremental Climate Change Implications

This option will result in a 20% reduction of GHG emissions relative to continued diesel-only power generation. CO2 emissions over the study period are estimated to be 0.098 megatonnes at Tadoule Lake, equivalent to 14,000 vehicles operating normally for one year.

By reducing diesel fuel requirements, this option will decrease GHG emissions associated with fuel transportation and decrease the fuel transportation risk and fuel supply challenges associated with diesel power generation

3.2.4 Incremental Socioeconomic Benefits

With duration of construction anticipated to be no more than 6 months, limited incremental opportunities for training and employment exist for this option. Operational responsibilities would be assumed by the existing diesel operator in the community. Infrequent service requiring specialized skills would be outsourced beyond the community because the volume of work would not be sufficient to maintain local proficiency.

There is some potential for short term direct business opportunities from this option, such as the transport of towers, blades and turbines; provision of project infrastructure; and erection of towers, and as with training and employment, the duration of opportunities is likely limited to construction. Existing capacity within the community is limited. Partnership with experienced companies would likely be required.

3.2.5 Incremental Economic Analysis

The net present value of augmenting diesel generation with wind power relative to status quo continued diesel generator operation was calculated over 35 years (2007 to 2042) using a real discount rate of 6% and assuming an annual wind power penetration ratio of 20%. Since the delivered cost of diesel fuel is the dominant cost associated with the operation of diesel generators, the economic analyses were performed using Manitoba Hydro's 2006 delivered diesel fuel price forecast (with an annual forecast price which varies from year to year) and at various constant annual fuel prices in order to determine the sensitivity of the results to fuel price and to determine the break-even fuel price for the options. Due to regulatory uncertainty, these analyses do not include a cost for CO2 emissions. Table 2 provides the results of the economic analysis for Tadoule Lake.

Table 2 – NPV of Augmenting Diesel Generation with Wind Power in Tadoule Lake Relative to Continued Diesel Generation
(NPV at 6% real discount rate, 35 year study period, 2006 $CDN)

Delivered Fuel Price ($/Litre)	**Tadoule Lake (NPV,2006 $CDN)**
MH 2006 Tadoule Lake Price Forecast	*$1,340,000*
$0.50	-$390,000
$0.60	-$12,000
$0.603	$0
$0.70	$370,000
$0.80	$740,000
$0.90	$1,120,000
$1.00	$1,500,000

The break-even delivered fuel price for this option is $0.603 per Litre for Tadoule Lake. The average annual delivered fuel prices associated with Manitoba Hydro's 2006 price forecasts are $0.97 per Litre at Tadoule Lake.

Based on Manitoba Hydro's forecast prices and approximate wind resource information, augmenting diesel generation with wind power in Tadoule Lake is slightly better than a break-even option. That is, the reduction in diesel fuel cost is greater than the capital and operating costs that would be incurred to install wind generation.

3.2.6 Summary

Table 3 summarizes the preliminary analysis of augmenting diesel generation with wind power for Tadoule Lake.

Table 3 – Summary of Option 1 – Wind Power

Aspect	Performance Relative to Continued Diesel Operation
Reliance on Diesel Power	Minor Reduction
Local Air Quality Effects	Minor Reduction
Terrestrial Effects	Minor increase
Aquatic Effects	No change
Socioeconomic Benefits	Minimal
Climate Change Implications	GHG reduction, Decreased transportation risk
NPV @ Forecast Fuel Prices	$1,340,000
Break-Even Fuel Price	$0.603 per Litre

3.3 Option 2 – Connection to the Transmission Grid

3.3.1 Overview of Option

This option will eliminate the use of diesel generation in the community of Tadoule Lake. In addition, this option would result in an upgrade of the service in the community from 60 Amp to 200 Amp.

Estimates for constructing and operating transmission service for Tadoule Lake were provided by Manitoba Hydro's Transmission & Distribution System Planning department in late 2005. These estimates are preliminary and carry a range of uncertainty of +/-50%. Should this option be selected for further analysis in the future, more accurate cost estimates are required.

Connection to the transmission grid would originate in Lynn Lake with a new transmission line from Lynn Lake to Brochet and a new transmission line from Brochet to Lac Brochet. If Tadoule Lake is to be grid connected as well, the connection would originate in Lac Brochet. However, if the transmission option is not implemented for Brochet and Lac Brochet, it will not be available for Tadoule Lake since the cost of constructing a line from Lynn Lake to Tadoule Lake alone would be prohibitive.

The assumed in service date for this option is 2013. This option includes the following major items to connect Tadoule Lake to Lac Brochet;

- Upgrades to the existing Lynn Lake Terminal transmission and protection equipment
- 160 km of 138 kV transmission line from Lac Brochet to Tadoule Lake
- Distribution system upgrades in Tadoule Lake
- Decommissioning of the diesel site

Only the costs associated with upgrading the distribution system from 60 amp to 200 amp service were included in this analysis. Costs associated with upgrading individual residences and business to accept 200 amp service have not been included.

Since this option will allow increased use of electrical services relative to the existing 60 Amp service, such as space heating, Manitoba Hydro's 200 Amp service load forecast was utilized in the economic analysis. This forecast assumes greater demand than that assumed in the 60 Amp forecast that is used in the analysis of Option 1.

It is anticipated that this option would require an Environment Act Licence and Federal screening which would require a minimum of two years to complete.

3.3.2 Incremental Environmental Effects

Local Air Quality Effects – this option will eliminate diesel generation thereby eliminating noise and emissions of NOx, SOx, CO, CO2, fine particulate matter, and UHC associated with diesel generation

Terrestrial Effects – this option will eliminate the diesel fuel spill potential associated with operation of fuel storage facilities. However, this option will result in a significant increase in land use as compared to the existing diesel generating station. The construction of the transmission line will result in 160 km of linear development. To a lesser degree, similar effects will be associated with ongoing line maintenance activities.

Environmental effects associated with linear developments are dealt with through proper route selection and mitigation techniques. Residual environmental impacts are not significant and are manageable. During the construction phase, there will be emissions and spill potential associated with the operation of heavy construction equipment. These impacts can also be mitigated through effective management/response programs and staff training.

Aquatic Effects – the transmission option will eliminate the diesel fuel spill potential associated with fuel storage facility operation. However, there is spill potential associated with ongoing line maintenance activities.

During the construction phase, there will be spill potential associated with the operation of heavy construction equipment and the potential for disruption of riparian zones at water crossings. These impacts can be mitigated through effective management/response programs and staff training.

3.3.3 Incremental Climate Change Implications

This option will eliminate the local GHG emissions associated with diesel power generation. Due to the fact that the community would now be supplied by hydro energy that may have otherwise been exported to the US, there may be no net global reduction in GHG emissions associated with this option since there may be an increase in GHG emissions in the US if increased dispatch of thermal units is required to compensate for reduced imports of hydro power. On a global scale, any change in GHG emissions associated with grid connection would be minimal, although a point source of emissions would be eliminated.

This option will also eliminate the fuel transportation risk and fuel supply challenges associated with diesel power generation.

3.3.4 Incremental Socioeconomic Benefits

The construction period associated with grid connection is approximately 1 to 2 years and would provide various skilled and unskilled employment opportunities that potentially could be filled by community residents. Incremental operational employment associated with a transmission line would be minimal.

The 200 amp option assumes that conversion of residences and businesses to accept 200 amp service is the burden of customers and creates temporary demand for electrical trade opportunities.

Grid connecting the community would also result in the loss of the local diesel station operator as an employment opportunity.

3.3.5 Incremental Economic Analysis

The net present value of connecting Tadoule Lake to the transmission grid relative to status quo continued diesel generator operation was calculated over 35 years (2007 to 2042) using a real discount rate of 6%. Since the delivered cost of diesel fuel is the dominant cost associated with the operation of diesel generators, the economic analysis was performed using Manitoba Hydro's 2006 delivered diesel fuel price forecast (with an annual forecast price which varies from year to year) and at various constant annual average fuel prices in order to determine the sensitivity of the results to fuel price and to determine the break-even fuel price for the option.

Based on Manitoba Hydro's 200 amp combined load forecasts for the community, the present value marginal energy cost to supply the community from the grid is estimated to be $6,340,000 over the study period assuming a marginal energy cost of $0.056/kWh. However, since this option would see the community absorbed into the general rate base and eliminate the existing "islanded" cost recovery structure, the incremental NPV of the transmission option was determined with and without the marginal cost of energy to allow comparisons to the "islanded" options with and without consideration of this cost. Table 4 provides the results of the economic analysis excluding the marginal cost of energy and Table 5 provides the results including the marginal cost of energy.

Table 4 – NPV of Connecting Tadoule Lake to the Transmission Grid
Relative to Continued Diesel Generation
Excluding Marginal Cost of Energy
(NPV at 6% real discount rate, 35 year study period, 2006 $CDN)

Delivered Fuel Price ($/Litre)	Grid Connection (NPV,2006 $CDN)
MH 2006 Forecast	*-$23,070,000*
$0.80	-$25,390,000
$0.90	-$23,930,000
$1.00	-$22,470,000
$1.20	-$19,550,000
$1.40	-$16,630,000
$1.60	-$13,710,000
$1.80	-$10,790,000
$2.00	-$7,860,000
$2.20	-$4,940,000
$2.40	-$2,020,000
$2.539	$0

Table 5 – NPV of Connecting Tadoule Lake to the Transmission Grid
Relative to Continued Diesel Generation
Including Marginal Cost of Energy
(NPV at 6% real discount rate, 35 year study period, 2006 $CDN)

Delivered Fuel Price ($/Litre)	Grid Connection (NPV,2006 $CDN)
MH 2006 Forecast	*-$29,410,000*
$1.00	-$28,810,000
$1.20	-$25,890,000
$1.40	-$22,970,000
$1.60	-$20,040,000
$1.80	-$17,120,000
$2.00	-$14,200,000
$2.20	-$11,280,000
$2.40	-$8,360,000
$2.60	-$5,440,000
$2.80	-$2,520,000
$2.973	$0

The break-even delivered fuel price for this option is $2.539 per Litre excluding the marginal cost of energy and $2.973 per Litre when the marginal cost of energy is included.

On the basis of Manitoba Hydro's 2006 fuel price forecast, this option is a net cost relative to continued operation of the diesel generating station at Tadoule Lake.

3.3.6 Summary

Table 6 summarizes the preliminary analysis of connection to the transmission grid.

Table 6 – Summary of Option 2 – Connection to the Transmission Grid

Aspect	Performance Relative to Continued Diesel Operation
Reliance on Diesel Power	Eliminate
Local Air Quality Effects	Eliminated
Terrestrial Effects	Significant Increase
Aquatic Effects	Significant decrease as it eliminates the potential for diesel fuel spills.
Socioeconomic Benefits	Minimal
Climate Change Implications	Eliminates local GHG emissions & fuel transportation risk. May not result in near term global GHG emissions
NPV @ Forecast Fuel Prices Excluding marginal energy cost	-$23,070,000
Break-Even Fuel Price Excluding marginal energy cost	$2.539 per Litre
NPV @ Forecast Fuel Prices Including marginal energy cost	-$29,410,000
Break-Even Fuel Price Including marginal energy cost	$2.973 per Litre

4.0 Home Heating Cost Implications of 200 Amp Service Option

Supply options which offer the potential to upgrade from 60A to 200A service create the opportunity for residential customers to convert from current heating systems which use fuel oil to electric baseboard heating systems. The average annual energy requirement for residential heat per household for Tadoule Lake is estimated to be 26,000 kWh (compared to 15,000 to 16,000 kWh in southern Manitoba). The fuel cost, at current prices, to meet this heat load with oil and electric heating systems are shown in Table 7 below. These values do not include operating and maintenance or heating system conversion costs.

Table 7 – Estimated 2006 Annual Residential Heating Fuel Costs (2006 $CDN)

Fuel	Heating System	Efficiency	Average Annual Cost per Household
Oil	Vented Space Heater	60%	$4,400
Oil	Forced Air Furnace	60 to 89%	$4,400 to $3,000
Electric	Baseboard	95%	$1,500

Appendix A - Technical & Environmental Screening of Potential Supply Options

A screening exercise was utilized to identify potential options for preliminary analysis. This appendix provides an explanation of the screening criteria and the results of the screening exercise.

Potential supply options were restricted to those that either reduce or eliminate the use of diesel-fired generation. Therefore, options such as small simple cycle aeroderivative gas turbine generators, which would have to burn diesel fuel in a remote location, were not considered as they do not meet this objective.

The option of upgrading the existing diesel generators to supply 200 Amp service was considered. The main driver for upgrading the service in the community from 60 Amps to 200 Amps is the use of electricity for residential space heating. If electricity for residential heating is supplied by diesel generators, the efficiency of the conversion of diesel energy to electricity is approximately 34% and the conversion efficiency of electricity to heat is approximately 95% for a total diesel-to-heat conversion efficiency of 34% X 95% = 32%. If diesel fuel is burned directly to provide heat for a residence, the diesel-to-heat conversion efficiency is in the range of 60% to 89% depending on the type of liquid fuel furnace that is used. Therefore, for the purpose of residential heating, burning diesel directly to produce heat is 1.9 to 2.8 times more efficient than burning diesel to produce electricity which is then used to produce heat. The use of diesel generators to supply 200 Amp service would therefore result in a significant increase in diesel consumption and associated emissions relative to 60 Amp operation and this option was therefore screened out for further evaluation as it does not meet the objective of reducing or eliminating the use of diesel-fired generation in Tadoule Lake.

Once options such as these are eliminated, there are still many potential supply options that meet the simple criterion of reducing or eliminating diesel-fired generation. In order to determine the options that merit further study for this application, a technical and environmental screening exercise was conducted. This Appendix summarizes the screening exercise.

Supply options that met the objective of either reducing or eliminating diesel generation were then assessed on the basis of 5 parameters relative to existing diesel-fired generators;

- *State of Technological Development* – Is the technology commercially available and proven? The existing diesel generators are a proven, mature technology.
- *Reliability & Maintainability* – Will the option perform reliably in severe cold weather conditions and can the option be maintained in a remote location?

From Manitoba Hydro's perspective, one of the primary considerations in evaluating power supply options for remote communities is reliability. Reciprocating diesel generating units have historically been chosen to supply remote, off-grid communities because of their proven high reliability and simple maintenance requirements relative to more complex thermal generation options such as steam turbine plants. For this reason, alternative supply options were evaluated relative to the performance of diesel generators to ensure that any new supply option chosen for analysis would not compromise the reliability of service in these remote communities.

- *Dispatchability* – Can the option be dispatched to meet demand? The existing diesel generators can be dispatched to meet changes in demand as required.
- *Environmental Effects* – What are the major environmental effects associated with the option? The existing diesel generators produce emissions of NOx, SOx, CO, CO2, fine particulate matter, and unburned hydrocarbons (UHC). Aquatic effects include groundwater contamination due to fuel spills and the risk of spills during fuel transportation over winter roads.
- *Fuel Supply* – What are the fuel supply availability, transportation, storage, and handling issues associated with the option? The existing diesel generators have certainty of fuel supply availability, but significant transportation challenges associated with use of winter roads and spill and soil contamination risks associated with fuel storage and handling.

Options with equivalent or superior performance over these five parameters relative to the existing diesel generators were selected for further analysis.

The results of the technical and environmental screening exercise are presented in Table A1 below.

Table A1 – Technical & Environmental Screening Results

Option	State of Technological Development	Reliability & Maintainability	Dispatchability	Environmental Effects	Fuel Supply	Acceptable?
Solar Photovoltaics	Commercially available, mature. However, not yet considered practical for large scale applications.	Unproven in these service conditions	Not dispatchable. Must be used in combination with a dispatchable supply option.	**Terrestrial** large footprint **Air Quality** N/A **Aquatics** N/A **Noise** N/A	Not applicable	No
Hydrogen Based Thermal Generation (reciprocating gensets fired with hydrogen)	Research & Development	Unproven, but assumed to be similar to existing diesel gensets (~95% plant availability)	Dispatchable	**Terrestrial** small footprint **Air Quality** not significant **Aquatics** not significant **Noise** constant process noise	Significant challenges associated with fuel supply, transportation, storage, and handling.	No
Biomass Based Thermal Generation (boiler and steam turbine for power generation)	Commercially available, immature.	Reliability assumed to be similar to coal fired generation (~85% plant availability). Significant challenges associated with ensuring adequate on site technical expertise, part supply, and support staff. Significant challenges associated with access to OEM and contract expertise.	Dispatchable	**Terrestrial** medium footprint, land use required for storage of ash **Air Quality** emissions of NOx , SOx, and particulate matter, but assumed to be CO2 neutral **Aquatics** water withdrawal for process steam and cooling, potential liquid effluent depending on ash handling process, possible groundwater contamination risk and risk of spills during fuel transportation **Noise** constant process noise.	Uncertainty associated with supply availability. Backup fuel supply, such as diesel would be required to ensure adequate supply is available at all times. Significant transportation challenges associated with use of winter roads, significant storage and handling challenges in extreme cold service conditions.	No
Wind Generation	Commercially available, mature.	see GEC report for Alaska experience	Not dispatchable. Must be used in combination with a dispatchable supply option.	**Terrestrial** medium footprint, potential for bird strikes and disruption to wildlife due to noise **Air Quality** N/A **Aquatics** N/A **Noise** Minor process noise	Unknown. Wind resource data required.	Yes

Table A1 (con't) – Technical & Environmental Screening Results

Option	State of Technological Development	Reliability & Maintainability	Dispatchability	Environmental Effects	Fuel Supply	Acceptable?
Small Hydro Generation	Commercially available, mature	~95% Plant availability, proven maintainability in these service conditions, reliability could be subject to stream flows and water levels	Dispatchable	**Terrestrial** large footprint **Air Quality** N/A **Aquatics** oil spill potential, turbidity potential, fish effects **Noise** constant process noise	Minimal water storage, supply subject to local stream flows and levels. Dependent on site identification and selection, and potential design	No
Connection to Transmission Grid	Commercially available, mature	~95% availability, proven maintainability in these service conditions	Dispatchable	**Terrestrial** large footprint **Air Quality** N/A **Aquatics** N/A **Noise** N/A	Not applicable	Yes
Existing Diesel Generators	Commercially available, mature	~95% Plant availability , proven maintainability in these service conditions	Dispatchable	**Terrestrial** small footprint **Air Quality** emissions of NOx, SOx, CO, CO2, fine particulate matter, and unburned hydrocarbons (UHC) **Aquatics** no water withdrawal or effluent streams, possible groundwater contamination risk, risk of spills during fuel transportation **Noise** constant process noise.	Good supply availability, significant transportation challenges associated with use of winter roads, spill and soil contamination risks with storage and handling.	N/A

Based on the screening exercise, the following options were excluded from further consideration;

- *Solar photovoltaics* – this option was excluded because it is not yet considered practical for large scale applications, has unproven reliability and maintainability in extreme cold weather service conditions, and is not dispatchable. The current technology has a very low annual capacity factor (~8%). This would pose significant challenges to integrating this technology with the existing diesel generators while ensuring reliability of service. However, this option could be considered as a possible option for individuals to reduce residential electricity demand.
- *Hydrogen-Based Thermal Generation* – this option was excluded because it is still in the R&D phase of technological development and has significant uncertainty and challenges associated with the supply, transportation, storage, and handling of hydrogen in severe service applications.
- *Biomass-Based Thermal Generation* – this option was excluded on the basis of its greater air and aquatic effects relative to existing diesel generation, the significant challenges associated with the handling and storage of ash, and the significant maintenance challenges associated with operating a steam power plant in a remote location without year-round road access. Fuel supply is also a concern as there is not a sustainable local feedstock available, and there are significant challenges associated with long distance fuel transportation, long term storage, and fuel handling. However, the use of biomass fuel could be considered as a possible option to replace fuel oil for home heating.

- *Small Hydro Generation* – The small hydro development option has been screened out of this study due to a number of issues including: the need to identify an appropriate site for small hydro applications, limited local hydrometric data, the need for a feasible station design and associated cost estimates, limited water storage, unknown environmental impacts, reliability, minimal long term employment opportunities, and the Heritage River designation of the Seal River. These issues need to be considered and resolved before small hydro development can be evaluated as an option for this community. This is not to say that the option will never be explored, but with these issues remaining an adequate evaluation cannot be performed.

  Although there are three sites within approximately 50 to 75km previously identified by Manitoba Hydro as having hydroelectric development potential, that potential was for large scale developments, and may not be suitable sites for small hydro development. Further study would be required to determine the adequacy of these sites for small hydro development. Table A2 below provides a summary of these sites:

Table A2 - Previously Identified Hydro Development Sites

Site Name	Head (m)	Potential Capacity (MW)
Porcupine	30	46
Bain Lake	18	29
Shethanie	18	68

Limited local hydrometric data is a significant reason why small hydro options have been excluded from study at this time. With the information currently available it is difficult to determine the potential for small hydro development, or to determine if local stream flows would be able to reliably supply the required dependable energy to the community well into the future.

In addition to stream flow data, water levels associated with the stream flows would be required to determine the developable head to provide dependable energy. High water levels associated with higher stream flow cases would also be required, as these levels could potentially wash out the tail water of a small hydro site if not properly designed, reducing the working head of the station, and diminishing generation capacity. This also could jeopardize the reliability of power supply to the community.

As a proxy for developable head requirements, data available from the Environment Canada HYDAT database for the nearest hydrometric measurement station to the community on the North Seal River, downstream of Stony Lake (site 06GB001), was evaluated for dependable supply. Records from this site are available from 1972 to 1994, during which the minimum monthly mean discharge recorded was $24.6m^3/s$, and there was limited water level data available to determine any substantial range of flow depths at this site. Table A3 shows the estimated development head required under minimum stream flow conditions to serve the forecast community energy and capacity requirements at 60 and 200 Amp service at the end of the study period. These values were calculated assuming 88% hydraulic efficiency, and assuming 100% stream flow is available for generation.

Table A3 - Development Head Requirements for 2042

	Forecast Requirements			
Service	Energy (MWh)	Head (m)	Capacity (kW)	Head (m)
60 Amp	7507	4.0	1652	7.8
200 Amp	14002	7.5	3797	17.9

If adequate hydrometric data were available for a potential development site, a station design that could serve the community needs well into the future is required, to ensure that the plant would minimally disrupt the local environment, allow for fish passage, and not inhibit traditional and recreational access through the area. Acceptable levels for these design parameters and others would also need to be established for design purposes. Once a design is established, cost estimates could be generated and analysis could be performed to determine the economic feasibility of the proposal. This also serves as a reason why small hydro development was not included in the supply options study at this time.

One important consideration for design that would need to be addressed is water storage. With a small hydro installation, it is likely that there would be only short term storage available with the weir design in order to minimize flow disruption, environmental impact, or traditional and recreational access. In terms of reliable energy supply, this leaves the community vulnerable to long term water shortages.

Small hydro development could also create a significant environmental impact depending on the channel geometry and hydraulic characteristics of a potential site, as well as the characteristics upstream and downstream of the site. In addition to station design work, studies of the potential impacts to the area would need to be completed if this option is to be realistically explored in the future.

During the evaluation of small hydro options for the Brochet and Lac Brochet study, the issues of reliability, limited socioeconomic benefit, and larger potential environmental impact incremental to existing diesel generation became evident. Reliability concerns would require maintaining the diesel generation facility to provide back-up generation for major unplanned outages, insufficient stream flows, and would be required for peak load service when community demand exceeds hydroelectric development potential at the station. Although community demand growth could be addressed by developing additional sites, if multiple sites exist, this raises the issue of excessive development and disruption to the natural environment. While reliability would be a concern under 60 Amp service, these concerns would be amplified under a 200 Amp service scenario.

The Brochet and Lac Brochet study also revealed that the potential employment opportunities outside of the construction period would likely be limited for a small hydro station. The diesel operator's position would still remain as the diesel generators would need to be maintained for reliability in the situations mentioned above.

On a purely economic basis, the small hydro option would be most advisably pursued for a 200 Amp supply option, due to the fact that the capital investment required would likely be a small increment compared to the cost of developing a station for 60 Amp service. However, it would also require an increased amount of diesel fired generation to be installed and maintained for reliability in the potential situations where diesel generation would still be needed as outlined above.

A Tadoule Lake small hydro site would likely be proposed on the north or south Seal Rivers which connect to form the Seal River. The Seal River is a Canadian Heritage River that was designated in 1992 for its unaltered, natural values. It was also nominated (to a lesser extent) for its ability to provide extremely rugged white-water wilderness recreational opportunities. There would be sensitivities to proposing small hydro development on a river that is connected to and affects a heritage river. Sensitivities such as protection of the wilderness environment, solitude, scenic areas, wildlife viewing and hiking opportunities would have to be considered as part of the environmental assessment process. The draft management planning document for the Seal River (1990) states that hydroelectric development on the Seal River would likely make it impossible to maintain the values for which the river has been nominated to the Canadian Heritage Rivers System.

The options that were selected for further analysis are as follows;

- *Augmenting Diesel Generation with Wind Power.* This option can only reduce, not eliminate, diesel generation because it is not dispatchable and must therefore be used in combination with existing diesel generators to ensure a continuous, reliable supply of power.
- *Connection to the Transmission Grid.* This option has the ability to completely eliminate diesel generation at Tadoule Lake. It is recognized that this option is dependant on a transmission line supply option being pursued for Brochet and Lac Brochet.

Appendix B - Summary of Assumptions

General Assumptions

- 6% real discount rate
- 2007 to 2042 study period (35 years)
- all costs in constant 2006 $CDN
- 2006 Manitoba Hydro 20 year delivered diesel price forecast for fiscal years 2006 to 2026. For the period beyond the forecast, 2027 to 2042, prices were held constant at their 2026 forecast values.
- 2.73 tonnes of CO2 are produced for each tonne of diesel burned

Load Forecast Growth Assumptions

Tadoule Lake

- 115 residential customers in 2007
    - residential growth of 2 houses per year assumed for both 60 amp and 200 amp service
- 37 general service customers in 2007
    - general service growth of 1 customer per year assumed for both 60 amp and 200 amp service

These assumptions apply to Manitoba Hydro's 2007 20 year load forecasts for 60 amp and 200 amp service (2007 to 2027). For the period beyond the forecast, 2028 to 2042, load growth of 2% per year was assumed for 60 amp service and load growth of 1% per year was assumed for 200 amp service. These percentage growth assumptions are based on average growth rates during the 2007 to 2027 forecast period.

Existing Diesel Generating Station Assumptions

Diesel Generator Replacement Cost

- $594 per kW, includes switchgear and installation
- based on Nov 2004 AMD Reciprocating Engine Power Services Process Review Final Report, AMD report no. AMD 2004-02

New Diesel Generator Capital Cost

- $891 per kW
- assumed new unit cost is 50% greater than replacement cost on a per kW basis

Non-Fuel Operating and Maintenance Cost

- $268,338 per year for Tadoule Lake
- based on 5 year average Manitoba Hydro SAP O&M order settlements

Diesel Generator Service Life

- 14 years
- based on the 2004/05 AMD North Diesel Generating Stations Report

Diesel Generator Thermal Efficiency

- 3.3 kWh per litre of diesel for Tadoule Lake
- based on the 2004/05 AMD North Diesel Generating Stations Report

Diesel Site Decommissioning Cost

- $3.0 million
- RPMA estimate based on thermal station decommissioning cost estimates

Wind Generation Assumptions

Wind Turbine Model

- Fuhrländer FL250
- 50 m tower height
- 29.5 m rotor diameter
- Based on the July 2006 Global Energy Concepts (GEC) report *Preliminary Analysis of Wind-Diesel Opportunities in Remote Manitoba Communities*

Wind Energy Penetration Rate

- 20% of annual energy demand
- Based on the July 2006 Global Energy Concepts (GEC) report *Preliminary Analysis of Wind-Diesel Opportunities in Remote Manitoba Communities*

In Service Dates

- Tadoule Lake – two turbines in 2013, a third turbine in 2019, and a fourth turbine in 2035

Capital Cost

- $3335 per kW
- Based on the July 2006 Global Energy Concepts (GEC) report *Preliminary Analysis of Wind-Diesel Opportunities in Remote Manitoba Communities*
- Assumed GEC cost estimate plus 15% to account for access roads and transmission lines.

Operating & Maintenance Cost

- $28.75 per kW
- Based on the July 2006 Global Energy Concepts (GEC) report *Preliminary Analysis of Wind-Diesel Opportunities in Remote Manitoba Communities*
- Assumed GEC cost estimate plus 15% to account for additional challenges associated with remote maintenance.

Turbine Service Life

- 25 years
- consistent with Manitoba Hydro wind evaluation methodology

Regulatory Process Cost & Duration

- $250,000, internal process cost estimate
- process time less than one year

138 kV Transmission Assumptions

In Service Date: 2013

Capital Costs (based on 2005 Manitoba Hydro estimates)
- Transmission station = $16.47 million
- Transmission line = $32.60 million

Operating & Maintenance Costs (Manitoba Hydro estimates)
- Transmission station = $32,868 per year
- Transmission line = $133,392.65 per year
- Marginal cost of energy = $0.056/kWh assuming load is served from northern generation

Transmission Service Lives
- Transmission station = 35 years
- Transmission line = 50 years
- Consistent with Manitoba Hydro evaluation methodology

Transmission Line Distances (Manitoba Hydro estimates)
- Lac Brochet to Tadoule Lake = 160 km

Regulatory Process Cost & Duration
- $600,000
- 2 year duration

Residential Heating Assumptions

N.E.M.A. formula inputs

- Heat Loss = 11.44
    - value for a 1000 sq. ft. bungalow with an unheated crawlspace
    - includes a 10% add-on for locations north of the 53rd parallel
- Constant = 14
    - Average for most homes
- Tadoule Lake Degree Days = 9047
    - Based on geographic location and indoor design temperature of 22°C
- Design Temperature Difference = 55°C
- Formula inputs based on values obtained from Manitoba Hydro's "Efficient Heating of Buildings Manual".

Oil Heating Systems

- Energy per litre of oil = 10.611 kWh
    - Based on 38.2 MJ/litre obtained from "Heating with Oil", available from Natural Resources Canada
- Vented space heater efficiency = 60%
- Forced air furnace efficiency range = 60 to 89%
    - Range covers a variety of potential furnace installations
- Fuel Oil heating efficiencies based on values obtained from "Heating with Oil", available from Natural Resources Canada
- Tadoule Lake 2006 Fuel Oil price = $1.09
- 2006 Fuel Oil Prices based on 2006 Manitoba Hydro 20 year delivered diesel price forecast for fiscal years 2006 to 2026

Electric Baseboard Heating

- Residential Rate Energy Charge = $0.05654
- Based on information obtained from Manitoba Hydro's Customer Policy Application Website

MANITOBA HYDRO

GENERATING RESOURCE SCREENING STUDY

SYNOPSIS: Preliminary analysis of potential centralized supply options that may reduce or eliminate 60 Amp diesel-fired generation in non grid-connected communities.

LOCATION: Shamattawa

DATE: October 2007
FINALIZED: November 2008

B. E.
JOHNSON
Member
24823

Executive Summary

As part of its ongoing planning activities and in response to requests from various stakeholders, Manitoba Hydro performed a preliminary analysis of potential alternatives to diesel-fired power generation for the community of Shamattawa. This analysis is intended to provide preliminary information to determine if more detailed analysis of a particular option is warranted.

Based on a technical and environmental screening process that considered several alternatives, two options were chosen for preliminary analysis; wind power and connection to the Manitoba transmission grid. Wind power must be used in conjunction with the existing diesel station and is therefore limited to 60 amp service. Connection to the transmission grid enables 200 amp service.

The environmental, socioeconomic, and cost characteristics associated with each option were analyzed relative to continued operation of the diesel generating station in order to allow incremental comparisons of the alternative supply options to ongoing diesel operation. The economic analyses of the options are presented in terms of the net present value of each option relative to continued operation of the diesel station and in terms of "break-even" fuel price. The break-even fuel price represents the fuel price at which the cost of continued operation of the diesel station is equivalent to the estimated cost of the option under evaluation, resulting in a net present value of zero. For comparative purposes, the average annual delivered fuel price associated with Manitoba Hydro's 2006 price forecasts is $0.95 per Litre at Shamattawa.

The incremental capital and operating costs associated with each option have been evaluated without consideration for which party would be responsible for incurring these costs. A more detailed analysis would take this into consideration and Manitoba Hydro would require contributions from the benefiting parties prior to undertaking any capital expenditures associated with the installation of new generation options.

Table 1 summarizes the results of the analysis of the 60 amp option relative to continued operation of the existing diesel generators.

Table 1 – Summary of Preliminary Analysis of 60 Amp Option Performance Relative to Continued Diesel Operation

(NPV at 6% real discount rate, 35 year study period, 2006 $CDN)

Aspect	Wind Power Augmentation Shamattawa (60 amp)
Reliance on Diesel Power	Minor Reduction
Local Air Quality Effects	Minor Reduction
Terrestrial Effects	Minor increase
Aquatic Effects	No Change
Socioeconomic Benefits	Minimal
Climate Change Implications	Minor Reductions
Incremental NPV @ Forecast Fuel Prices (2006 $CDN)	$1,440,000
Break-Even Fuel Price ($ per Litre) Based on continued operation of 60 Amp diesel station	$0.705
Total Capital Cost Over Study Period (2006 $ CDN)	$10,050,000

It must be noted that the annual wind energy assumed in this evaluation is now considered optimistic for a low-penetration option. The 20% annual energy assumption was made based on information available at the time. The level of achievable instantaneous capacity penetration is another limiting factor that will need to be investigated and addressed if this option is identified for further study. Manitoba Hydro is currently evaluating potential wind penetration levels further for the remote diesel communities based on both instantaneous capacity and annual energy penetration criteria. Should these evaluations indicate that achievable penetration levels are lower than those assumed in this study, the resulting reductions in diesel generation are expected to result in reduced economic benefits for the wind/diesel option.

The wind/diesel option also includes the addition of a 425 kW diesel generator with the wind turbines, in order to better follow the fluctuation in wind generation levels. Such load following would be more difficult and less efficient using the larger diesel generators currently on-site.

As for the 60 Amp option, the net present value of the 200 amp option is incremental to continued 60 amp diesel operation. The analysis of the 200 amp option does not include the costs associated with conversion of individual residences to accept 200 amp service or the cost savings associated with switching to electricity for home heating.

For the transmission connection option, the present value marginal cost of the energy required to supply the forecast 200 Amp demand for the community is estimated to be $9,560,000 over the study period assuming a marginal cost of $0.056/kWh. However, since this option would see the communities absorbed into the general rate base and eliminate the existing “islanded” cost recovery structure, the incremental NPV of the transmission option is provided with and without the marginal cost of energy to allow comparisons to the “islanded” options with and without consideration of this cost. Table 2 summarizes the results of the analysis of the 200 amp option.

Table 2 – Summary of Preliminary Analysis of 200 Amp Option Performance Relative to Continued Diesel Operation

(NPV at 6% real discount rate, 35 year study period, 2006 $CDN)

Aspect	Transmission Connection (200 amp)
Reliance on Diesel Power	Eliminate
Local Air Quality Effects	Eliminate
Terrestrial Effects	Significant Increase
Aquatic Effects	Significant potential decrease as it eliminates potential for diesel fuel spills
Socioeconomic Benefits	Minimal
Climate Change Implications	Local GHG emissions eliminated. May not decrease near-term global GHG emissions.
Incremental NPV @ Forecast Fuel Prices (2006 $CDN)	-$11,940,000 (excluding marginal energy cost) -$21,500,000 (including marginal energy cost)
Break-Even Fuel Price ($ per Litre) Based on continued operation of 60 Amp diesel station	$1.40 (excluding marginal energy cost) $ 1.771 (including marginal energy cost)
Total Capital Cost Over Study Period (2006 $ CDN)	$51,260,000

Connection to the transmission grid is the only option that eliminates diesel generation and provides 200 amp service. The wind power option results in a reduction in diesel generation, however a more detailed study using site-specific wind resource data is required before an accurate determination of wind generation potential can be made. The incremental socioeconomic benefits associated with all options are minimal, with construction activities providing the majority of the benefits in all cases.

This preliminary analysis is intended to provide only comparative indications of the attractiveness of the supply options relative to continued operation of the diesel generating station. Should one or more of the options be selected as potential candidates for further consideration, more rigorous environmental, socioeconomic, and economic evaluations will be required for decision-making purposes.

EXECUTIVE SUMMARY i

1.0 INTRODUCTION 1

2.0 TECHNICAL & ENVIRONMENTAL SCREENING OF POTENTIAL SUPPLY OPTIONS 3

3.0 PRELIMINARY ANALYSIS OF SELECTED SUPPLY OPTIONS 5

3.1 Current State – Continued Operation of Diesel Generating Stations 5
- 3.1.1 Overview of Option 5
- 3.1.2 Environmental Effects 6
- 3.1.3 Climate Change Implications 6
- 3.1.4 Socioeconomic Benefits 7
- 3.1.5 Cost Analysis 7

3.2 Option 1 – Augmenting Diesel Generation with Wind Power 8
- 3.2.1 Overview of Option 8
- 3.2.2 Incremental Environmental Effects 9
- 3.2.3 Incremental Climate Change Implications 10
- 3.2.4 Incremental Socioeconomic Benefits 10
- 3.2.5 Incremental Economic Analysis 11
- 3.2.6 Summary 13

3.3 Option 2 – Connection to the Transmission Grid 14
- 3.3.1 Overview of Option 14
- 3.3.2 Incremental Environmental Effects 15
- 3.3.3 Incremental Climate Change Implications 15
- 3.3.4 Incremental Socioeconomic Benefits 16
- 3.3.5 Incremental Economic Analysis 16
- 3.3.6 Summary 18

4.0 HOME HEATING COST IMPLICATIONS OF 200 AMP SERVICE OPTION 19

APPENDIX A - TECHNICAL & ENVIRONMENTAL SCREENING OF POTENTIAL SUPPLY OPTIONS A-1

APPENDIX B - SUMMARY OF ASSUMPTIONS B-1

1.0 Introduction

Manitoba Hydro operates reciprocating diesel generating units to supply power to the remote communities of Brochet, Lac Brochet, Shamattawa, and Tadoule Lake. This report summarizes the preliminary analysis of several potential supply alternatives for the community of Shamattawa.

While there are no operational or reliability concerns associated with the existing diesel generating station at Shamattawa, Manitoba Hydro regularly evaluates opportunities to improve the performance of these assets. In addition, the PUB, Indian and Northern Affairs Canada (INAC), MKO, the Government of Manitoba, and other stakeholders have expressed interest in reducing or eliminating the use of diesel for power generation at these sites and in reducing the cost of service in off-grid communities.

The scope of this preliminary analysis includes the following;

- Identification of potential non-fossil fuel burning centralized power generation technologies that may be used to either reduce or eliminate continued diesel generation in the community of Shamattawa
- Connection to the transmission grid
- Analysis of the environmental effects, social effects, and costs associated with potential alternative power generation resources
- Identification and analysis of resource options that provide 200 amp service

The scope of this analysis does not include;

- Analysis of distributed power generation options, such as solar panels
- Analysis of demand side management opportunities available to the community as these were assumed to affect all potential supply options equally
- Analysis of combined heat and power applications
- Detailed analysis of home heating options and associated costs available to individual residences and businesses
- Analysis of the costs that individual residences and business may incur to upgrade to 200 amp service
- Soil remediation costs. Only diesel site decommissioning costs were considered

These analyses are preliminary in nature and are intended to provide only comparative indications of the attractiveness of the supply options relative to continued operation of the diesel generating station. Should one or more of the options be selected as potential candidates for further consideration, more rigorous environmental, socioeconomic, and economic evaluations will be required for decision-making purposes.

2.0 Technical & Environmental Screening of Potential Supply Options

Potential supply options were restricted to those that either reduce or eliminate the use of diesel-fired generation. The options that met this objective were then assessed on the basis of the following 5 parameters in order to identify those options that are appropriate for this application;

- State of Technological Development – is the technology commercially available and proven?
- Reliability & Maintainability – will the option perform reliably in severe cold weather conditions and can the option be maintained in a remote location with limited road access?
- Dispatchability – can the option be dispatched to meet demand?
- Fuel Supply – what are the fuel supply availability, transportation, storage, and handling issues associated with the option?
- Environmental Effects – what are the major environmental effects on land, air, and water associated with the option?

Appendix A provides a summary of the results of the technical and environmental screening exercise. The options selected for preliminary analysis based on this exercise are as follows;

- *Option 1 – Augmenting Diesel Generation with Wind Power.* This option will reduce diesel generation. Replacement is not feasible because wind is not dispatchable and must therefore be used in combination with other sources of dispatchable power. This analysis assumes that wind will be used in combination with the existing diesel generators to ensure a continuous, reliable supply of power.
- *Option 2 – Connection to the Transmission Grid.* This option has the ability to completely eliminate the requirement for diesel generation at Shamattawa.

The option of supplying 200 Amp service with diesel generators was considered but was screened out. The main driver for increasing service from 60 Amps to 200 Amps in the community of Shamattawa is the use of electricity for residential space heating. However, using diesel to heat a home directly with a liquid fuel furnace is approximately 1.9 to 2.8 times more efficient than using diesel to generate electricity which is then used to heat a home with resistive heaters. Therefore, the use of diesel generators to supply 200 Amp service to supply additional electricity for residential space heating would result in a significant increase in diesel consumption and associated emissions relative to 60 Amp operation. This option was therefore screened out for further evaluation as it does not meet the objective of reducing or eliminating the use of diesel-fired generation.

3.0 Preliminary Analysis of Selected Supply Options

The two supply options were evaluated on the basis of their environmental, social, and cost characteristics relative to continued operation of the diesel generating station at Shamattawa. In addition, the climate change implications of the options are discussed.

The existing diesel generating station in Shamattawa is assumed to continue normal operation until each option is fully installed and operational. Given the varying construction and regulatory lead times associated with the options, the assumed in service dates may be delayed based on the timing of a decision to commit to a particular option.

The economic analyses of the options are presented in terms of the net present value of each option relative to continued operation of the diesel station and in terms of "break-even" fuel price. The break-even fuel price represents the fuel price at which the cost of continued operation of the diesel station is equivalent to the estimated cost of the option under evaluation, resulting in a net present value of zero.

Manitoba Hydro's intention is to share this screening study with the community, their representatives and INAC for their review, comment and further discussion. As Manitoba Hydro's policy with respect to service extension is that the customer or customer group requesting or benefiting from the provision of service must pay for the service, discussions regarding funding and commitments must be in place prior to progressing to the next stage of detailed evaluation and design.

3.1 Current State – Continued Operation of Diesel Generating Stations

3.1.1 Overview of Option

The diesel generating station at Shamattawa includes three 1015 kW units for a station total capacity of 3,045 kW. Additional reciprocating diesel generating units will be added at the station to meet increases in electrical demand over time.

The diesel generators installed at the station have thermal efficiencies of approximately 34% which is on par with current reciprocating diesel engine technology. Future improvements in diesel engine technology may provide opportunity to install more thermally efficient units as existing units reach the end of their service lives, but thermal efficiency improvements are not currently anticipated to be significant as diesel engine technology is mature with little significant research and development taking place.

Potential soil remediation costs associated with past, present, or future operation of the diesel site have not been included in this analysis.

3.1.2 Environmental Effects

Local Air Quality Effects – operation of diesel generators results in emissions of NOx, SOx, CO, CO2, fine particulate matter, and unburned hydrocarbons (UHC). In addition, diesel generators produce constant process noise.

Terrestrial Effects – operation of diesel generators requires land use for the generating station, the fuel storage tank farm, access roads to the station and tank farm, and the transmission lines from the station. Diesel fuel spill potential is associated with the operation of the fuel storage facility and associated piping which can result in soil, surface, and ground water contamination. There is also spill potential associated with fuel transportation.

Aquatic Effects – operation of diesel generators does not require water withdrawal and involves no liquid effluent streams. The greatest risk to aquatic life occurs during the diesel truck haul over the winter road system and the ever present potential of vehicle and load loss due to bad ice conditions.

3.1.3 Climate Change Implications

Over the study period from 2007 to 2042, CO2 emissions associated with operation of the Shamattawa diesel generating station will total approximately 0.22 megatonnes based on Manitoba Hydro's 2006 load forecasts. This is equivalent to 32,000 vehicles operating normally for one year. This translates to an annual average of 6,400 tonnes, which is equivalent to 910 vehicles operating normally for one year, or approximately 0.032% of Manitoba's total annual GHG emissions.

One of the potential effects of climate change is increased and more extreme ambient temperature variability. This poses fuel transportation risk due to potential decreases in the duration of the winter road season. In addition, potential challenges to maintaining adequate on site fuel supplies will be associated with increased and more extreme temperature variability.

3.1.4 Socioeconomic Benefits

One plant operator is employed in the community and maintenance activities provide contract employment to local residents. In addition, the community receives an economic benefit of approximately $0.03/L from the diesel fuel that is consumed for power generation.

3.1.5 Cost Analysis

The present value cost of continued operation of the diesel generating station at Shamattawa was calculated over 35 years (2007 to 2042) using a real discount rate of 6%. Since the delivered cost of diesel fuel is the dominant cost associated with the operation of diesel generators, the economic analyses were performed using Manitoba Hydro's 2006 delivered diesel fuel price forecasts for the community (with delivered prices that vary from year to year) and at various constant annual fuel prices in order to determine the sensitivity of the results to fuel price. The delivered fuel price forecasts differ for each community due to differences in transportation costs. Costs associated with air emissions have not been included in these analyses. Table 1 provides the results of the present value cost analysis for Shamattawa.

Table 1 – Present Value Cost of Continued Diesel Generation at Shamattawa

Delivered Fuel Price ($/Litre)	Shamattawa (PV,2006 $CDN)
MH 2006 Shamattawa Price Forecast	*$40,780,000*
$0.70	$32,510,000
$0.80	$35,940,000
$0. 90	$39,370,000
$1.00	$42,800,000
$1.10	$46,230,000

The average annual delivered fuel prices associated with Manitoba Hydro's 2006 price forecasts are $0.95 per Litre at Shamattawa.

3.2 Option 1 – Augmenting Diesel Generation with Wind Power

3.2.1 Overview of Option

Wind generation is not dispatchable to meet demand and therefore must be used in combination with the existing diesel generators at Shamattawa to ensure a continuous, reliable supply of power to the community. This option will decrease, but will not eliminate the use of diesel generation. In addition, since this option works in combination with the existing diesel generators, the community would continue to be provided with 60 Amp service.

In order to determine the feasibility of installing wind generation in combination with existing diesel generators, Manitoba Hydro retained Global Energy Concepts, LLC (GEC) in 2006 to conduct preliminary feasibility studies for the communities of Brochet, Lac Brochet, Tadoule Lake, and Shamattawa. The recommendations and results of GEC's study formed the basis of Manitoba Hydro's preliminary analysis of the use of wind power in Shamattawa.

Since no site-specific wind resource data were available, GEC utilized data from the *Canadian Wind Energy* Atlas and Environment Canada to estimate the wind resource potential for Shamattawa. Site-specific wind data will be required if this option is selected for more detailed analysis. While a wind monitoring program has been implemented, the data has not yet been made available to Manitoba Hydro.

GEC recommends that wind energy installations in the off-grid communities be initially limited to 20% of annual energy demand (20% penetration) until sufficient operating experience is gained with the operation of wind-diesel systems. Alaskan communities that operate wind-diesel systems have found this level of penetration compatible with existing diesel generators without requiring costly and sophisticated controls and voltage stability equipment. For these reasons, Manitoba Hydro based its analysis of the wind-diesel option on a penetration level of 20% in the community.

It must be noted that the annual wind energy assumed in this evaluation is now considered optimistic for a low-penetration option. The 20% annual energy assumption was made based on information available at the time. The level of achievable instantaneous capacity penetration is another limiting factor that will need to be investigated and addressed if this option is identified for further study. Manitoba Hydro is currently evaluating potential wind penetration levels further for the remote diesel communities based on both instantaneous capacity and annual energy penetration criteria. Should these evaluations indicate that achievable penetration levels are lower than those assumed in this study, the resulting reductions in diesel generation are expected to result in reduced economic benefits for the wind/diesel option.

The wind turbine assumed in this analysis is the Fuhrländer FL250. This is a 250 kW wind turbine with a tower height of 42 m that can operate in ambient temperatures as low as -40°C. Fuhrländer is designing a tilt-up tower for this model which does not require a crane for erection. Since the tower design is not commercially available, GEC estimated the capital cost of the unit based on the use of custom-designed towers. The capital cost estimate has a range of uncertainty of -10% to +30%. For this analysis, Manitoba Hydro assumed the GEC capital cost estimate plus 15% to account for transmission equipment and the construction of access roads to the wind turbines.

Wind turbines would be located at the site to operate in combination with the existing diesel generators. Wind turbines would be added as energy demand grows to maintain the 20% penetration target. At Shamattawa, turbines are assumed to be installed as follows; four turbines in 2013, a fifth turbine in 2020, a sixth turbine in 2027, and a seventh turbine in 2035.

An additional 425kW diesel generator was assumed to be installed in 2013, which was recommended by GEC to better compensate for the fluctuations in wind generation and times of low load and high wind generation. The larger generators currently in Shamattawa would not operate as efficiently while responding to output changes, or under low load and high wind generation conditions.

It is anticipated that this option would not require an Environment Act Licence or Federal screening and would be subject only to Provincial review which would require a maximum of one year to complete.

3.2.2 Incremental Environmental Effects

Local Air Quality Effects – this option will result in a net reduction in emissions of NOx, SOx, CO, CO2, fine particulate matter, and UHC. associated with diesel generation. Since a penetration level of 20% is assumed in this analysis, it can reasonably be assumed that a similar annual decrease in these emissions would be associated with this option.

Terrestrial Effects – this option will result in a net increase in the land use associated with power generation as additional land will be required for the erection of wind turbines, access roads to the turbines, and transmission lines from the turbines. Construction phase terrestrial effects are expected to be minimal.

Although recent studies have shown that wind turbine effects on birds are decreasing, there is still the potential for bird strikes. To minimize potential adverse impacts siting of wind turbines should be outside the main bird migration routes. There are no known bird species at risk as defined by the federal Species at Risk Act or the provincial Manitoba Endangered Species Act in the project area. Noise caused by movement of the blades can also cause disruption to wildlife.

Aquatic Effects – this option will result in no change to the aquatic effects associated with diesel generation. Construction phase aquatic effects are expected to be minimal.

3.2.3 Incremental Climate Change Implications

This option will result in a 20% reduction of GHG emissions relative to continued diesel-only power generation. CO2 emissions over the study period are estimated to be 0.177 megatonnes at Shamattawa, equivalent to 25,000 vehicles operating normally for one year.

By reducing diesel fuel requirements, this option will decrease GHG emissions associated with fuel transportation and decrease the fuel transportation risk and fuel supply challenges associated with diesel power generation.

3.2.4 Incremental Socioeconomic Benefits

With duration of construction anticipated to be no more than 6 months, limited incremental opportunities for training and employment exist for this option. Operational responsibilities would be assumed by the existing diesel operator in the community. Infrequent service requiring specialized skills would be outsourced beyond the community because the volume of work would not be sufficient to maintain local proficiency.

There is some potential for short term direct business opportunities from this option, such as the transport of towers, blades and turbines; provision of project infrastructure; and erection of towers, and as with training and employment, the duration of opportunities is likely limited to construction. Existing capacity within the community is limited. Partnership with experienced companies would likely be required.

3.2.5 Incremental Economic Analysis

The net present value of augmenting diesel generation with wind power relative to status quo continued diesel generator operation was calculated over 35 years (2007 to 2042) using a real discount rate of 6% and assuming an annual wind power penetration ratio of 20%. Since the delivered cost of diesel fuel is the dominant cost associated with the operation of diesel generators, the economic analyses were performed using Manitoba Hydro's 2006 delivered diesel fuel price forecast (with an annual forecast price which varies from year to year) and at various constant annual fuel prices in order to determine the sensitivity of the results to fuel price and to determine the break-even fuel price for the options. Due to regulatory uncertainty, these analyses do not include a cost for CO2 emissions. Table 2 provides the results of the economic analysis for Shamattawa.

Table 2 – NPV of Augmenting Diesel Generation with Wind Power in Shamattawa Relative to Continued Diesel Generation
(NPV at 6% real discount rate, 35 year study period, 2006 $CDN)

Delivered Fuel Price ($/Litre)	Shamattawa (NPV,2006 $CDN)
MH 2006 Shamattawa *Price Forecast*	*$1,440,000*
$0.60	-$660,000
$0.70	-$30,000
$0.705	$0
$0.80	$590,000
$0.90	$1,210,000
$1.00	$1,840,000
$1.10	$2,460,000

The break-even delivered fuel price for this option is $0.705 per Litre for Shamattawa. The average annual delivered fuel price associated with Manitoba Hydro's 2006 price forecasts are $0.95 per Litre at Shamattawa.

Based on Manitoba Hydro's forecast prices and approximate wind resource information, augmenting diesel generation with wind power in Shamattawa is slightly better than a break-even option. That is, the reduction in diesel fuel cost is greater than the capital and operating costs that would be incurred to install wind generation.

3.2.6 Summary

Table 3 summarizes the preliminary analysis of augmenting diesel generation with wind power for Shamattawa.

Table 3 – Summary of Option 1 – Wind Power

Aspect	Performance Relative to Continued Diesel Operation
Reliance on Diesel Power	Minor Reduction
Local Air Quality Effects	Minor Reduction
Terrestrial Effects	Minor increase
Aquatic Effects	No change
Socioeconomic Benefits	Minimal
Climate Change Implications	GHG reduction, Decreased transportation risk
NPV @ Forecast Fuel Prices	$1,440,000
Break-Even Fuel Price	$0.705 per Litre

3.3 Option 2 – Connection to the Transmission Grid

3.3.1 Overview of Option

This option will eliminate the use of diesel generation in the community of Shamattawa. In addition, this option would result in an upgrade of the service in the community from 60 Amp to 200 Amp.

Estimates for constructing and operating transmission service for Shamattawa were provided by Manitoba Hydro's Transmission & Distribution System Planning department in late 2005. These estimates are preliminary and carry a range of uncertainty of +/-50%. Should this option be selected for further analysis in the future, more accurate cost estimates are required.

Connection to the transmission grid would originate at Radisson Station to Shamattawa.

The assumed in service date for this option is 2013. This option includes the following major items;

- Upgrades to the existing Radisson Station Terminal transmission and protection equipment
- 170 km of 138 kV transmission line from Radisson Station to Shamattawa
- Distribution system upgrades in Shamattawa
- Decommissioning of the diesel site

Only the costs associated with upgrading the distribution system from 60 amp to 200 amp service were included in this analysis. Costs associated with upgrading individual residences and business to accept 200 amp service have not been included.

Since this option will allow increased use of electrical services relative to the existing 60 Amp service, such as space heating, Manitoba Hydro's 200 Amp service load forecast was utilized in the economic analysis. This forecast assumes greater demand than that assumed in the 60 Amp forecast that is used in the analysis of Option 1.

The Shamattawa Diesel Generating Station was commissioned in 2003, so it is assumed that there is remaining salvage value in the diesel generators at the time they would be decommissioned after the community is grid connected. This salvage value has been included in the analysis.

It is anticipated that this option would require an Environment Act Licence and Federal screening which would require a minimum of two years to complete.

3.3.2 Incremental Environmental Effects

Local Air Quality Effects – this option will eliminate diesel generation thereby eliminating noise and emissions of NOx, SOx, CO, CO2, fine particulate matter, and UHC associated with diesel generation

Terrestrial Effects – this option will eliminate the diesel fuel spill potential associated with operation of fuel storage facilities. However, this option will result in a significant increase in land use as compared to the existing diesel generating station. The construction of the transmission line will result in 170 km of linear development. To a lesser degree, similar effects will be associated with ongoing line maintenance activities.

Environmental effects associated with linear developments are dealt with through proper route selection and mitigation techniques. Residual environmental impacts are not significant and are manageable. During the construction phase, there will be emissions and spill potential associated with the operation of heavy construction equipment. These impacts can also be mitigated through effective management/response programs and staff training.

Aquatic Effects – the transmission option will eliminate the diesel fuel spill potential associated with fuel storage facility operation. However, there is spill potential associated with ongoing line maintenance activities.

During the construction phase, there will be spill potential associated with the operation of heavy construction equipment and the potential for disruption of riparian zones at water crossings. These impacts can be mitigated through effective management/response programs and staff training.

3.3.3 Incremental Climate Change Implications

This option will eliminate the local GHG emissions associated with diesel power generation. Due to the fact that the community would be supplied by hydro energy that may have otherwise been exported to the US, there may be no net global reduction in GHG emissions associated with this option since there may be an increase in GHG emissions in the US if increased dispatch of thermal units is required to compensate for reduced imports of hydro power. On a global scale, any change in GHG emissions associated with grid connection would be minimal, although a point source of emissions would be eliminated.

This option will also eliminate the fuel transportation risk and fuel supply challenges associated with diesel power generation.

3.3.4 Incremental Socioeconomic Benefits

The construction period associated with grid connection is approximately 1 to 2 years and would provide various skilled and unskilled employment opportunities that potentially could be filled by community residents. Incremental operational employment associated with a transmission line would be minimal.

The 200 amp option assumes that conversion of residences and businesses to accept 200 amp service is the burden of customers and creates temporary demand for electrical trade opportunities.

Grid connecting the community would also result in the loss of the local diesel station operator as an employment opportunity.

3.3.5 Incremental Economic Analysis

The net present value of connecting Shamattawa to the transmission grid relative to status quo continued diesel generator operation was calculated over 35 years (2007 to 2042) using a real discount rate of 6%. Since the delivered cost of diesel fuel is the dominant cost associated with the operation of diesel generators, the economic analysis was performed using Manitoba Hydro's 2006 delivered diesel fuel price forecast (with an annual forecast price which varies from year to year) and at various constant annual average fuel prices in order to determine the sensitivity of the results to fuel price and to determine the break-even fuel price for the option.

Based on Manitoba Hydro's 200 amp combined load forecasts for the community, the present value marginal energy cost to supply the community from the grid is estimated to be $9,560,000 over the study period assuming a marginal energy cost of $0.056/kWh. However, since this option would see the community absorbed into the general rate base and eliminate the existing "islanded" cost recovery structure, the incremental NPV of the transmission option was determined with and without the marginal cost of energy to allow comparisons to the "islanded" options with and without consideration of this cost. Table 4 provides the results of the economic analysis excluding the marginal cost of energy and Table 5 provides the results including the marginal cost of energy.

Table 4 – NPV of Connecting Shamattawa to the Transmission Grid Relative to Continued Diesel Generation Excluding Marginal Cost of Energy

(NPV at 6% real discount rate, 35 year study period, 2006 $CDN)

Delivered Fuel Price ($/Litre)	Grid Connection (NPV,2006 $CDN)
MH 2006 Forecast	*-$11,940,000*
$0.80	-$15,460,000
$0.90	-$12,880,000
$1.00	-$10,300,000
$1.10	-$7,730,000
$1.20	-$5,150,000
$1.30	-$2,570,000
$1.40	$0

Table 5 – NPV of Connecting Shamattawa to the Transmission Grid Relative to Continued Diesel Generation Including Marginal Cost of Energy

(NPV at 6% real discount rate, 35 year study period, 2006 $CDN)

Delivered Fuel Price ($/Litre)	Grid Connection (NPV,2006 $CDN)
MH 2006 Forecast	*-$21,500,000*
$0.80	-$25,020,000
$0.90	-$22,440,000
$1.00	-$19,860,000
$1.10	-$17,290,000
$1.20	-$14,710,000
$1.30	-$12,130,000
$1.40	-$9,550,000
$1.50	-$6,980,000
$1.60	-$4,400,000
$1.70	-$1,820,000
$1.771	$0

The break-even delivered fuel price for this option is $1.40 per Litre excluding the marginal cost of energy and $1.771 per Litre when the marginal cost of energy is included.

On the basis of Manitoba Hydro's 2006 fuel price forecast, this option is a net cost relative to continued operation of the diesel generating station at Shamattawa.

3.3.6 Summary

Table 6 summarizes the preliminary analysis of connection to the transmission grid.

Table 6 – Summary of Option 2 – Connection to the Transmission Grid

Aspect	Performance Relative to Continued Diesel Operation
Reliance on Diesel Power	Eliminate
Local Air Quality Effects	Eliminated
Terrestrial Effects	Significant Increase
Aquatic Effects	Significant decrease as it eliminates the potential for diesel fuel spills.
Socioeconomic Benefits	Minimal
Climate Change Implications	Eliminates local GHG emissions & fuel transportation risk. May not result in near term global GHG emissions
NPV @ Forecast Fuel Prices Excluding marginal energy cost	-$11,940,000
Break-Even Fuel Price Excluding marginal energy cost	$1.40 per Litre
NPV @ Forecast Fuel Prices Including marginal energy cost	-$21,500,000
Break-Even Fuel Price Including marginal energy cost	$1.771 per Litre

4.0 Home Heating Cost Implications of 200 Amp Service Option

Supply options which offer the potential to upgrade from 60A to 200A service create the opportunity for residential customers to convert from current heating systems which use fuel oil to electric baseboard heating systems. The average annual energy requirement for residential heat per household for Shamattawa is estimated to be 22,000 kWh (compared to 15,000 to 16,000 kWh in southern Manitoba). The fuel cost, at current prices, to meet this heat load with oil and electric heating systems are shown in Table 7 below. These values do not include operating and maintenance or heating system conversion costs.

Table 7 – Estimated 2006 Annual Residential Heating Fuel Costs (2006 $CDN)

Fuel	Heating System	Efficiency	Average Annual Cost per Household
Oil	Vented Space Heater	60%	$3,700
Oil	Forced Air Furnace	60 to 89%	$3,700 to $2,500
Electric	Baseboard	95%	$1,300

Appendix A - Technical & Environmental Screening of Potential Supply Options

A screening exercise was utilized to identify potential options for preliminary analysis. This appendix provides an explanation of the screening criteria and the results of the screening exercise.

Potential supply options were restricted to those that either reduce or eliminate the use of diesel-fired generation. Therefore, options such as small simple cycle aeroderivative gas turbine generators, which would have to burn diesel fuel in a remote location, were not considered as they do not meet this objective.

The option of upgrading the existing diesel generators to supply 200 Amp service was considered. The main driver for upgrading the service in the community from 60 Amps to 200 Amps is the use of electricity for residential space heating. If electricity for residential heating is supplied by diesel generators, the efficiency of the conversion of diesel energy to electricity is approximately 34% and the conversion efficiency of electricity to heat is approximately 95% for a total diesel-to-heat conversion efficiency of 34% X 95% = 32%. If diesel fuel is burned directly to provide heat for a residence, the diesel-to-heat conversion efficiency is in the range of 60% to 89% depending on the type of liquid fuel furnace that is used. Therefore, for the purpose of residential heating, burning diesel directly to produce heat is 1.9 to 2.8 times more efficient than burning diesel to produce electricity which is then used to produce heat. The use of diesel generators to supply 200 Amp service would therefore result in a significant increase in diesel consumption and associated emissions relative to 60 Amp operation and this option was therefore screened out for further evaluation as it does not meet the objective of reducing or eliminating the use of diesel-fired generation in Shamattawa.

Once options such as these are eliminated, there are still many potential supply options that meet the simple criterion of reducing or eliminating diesel-fired generation. In order to determine the options that merit further study for this application, a technical and environmental screening exercise was conducted. This Appendix summarizes the screening exercise.

Supply options that met the objective of either reducing or eliminating diesel generation were then assessed on the basis of 5 parameters relative to existing diesel-fired generators;

- *State of Technological Development* – Is the technology commercially available and proven? The existing diesel generators are a proven, mature technology.
- *Reliability & Maintainability* – Will the option perform reliably in severe cold weather conditions and can the option be maintained in a remote location?

From Manitoba Hydro's perspective, one of the primary considerations in evaluating power supply options for remote communities is reliability. Reciprocating diesel generating units have historically been chosen to supply remote, off-grid communities because of their proven high reliability and simple maintenance requirements relative to more complex thermal generation options such as steam turbine plants. For this reason, alternative supply options were evaluated relative to the performance of diesel generators to ensure that any new supply option chosen for analysis would not compromise the reliability of service in these remote communities.

- *Dispatchability* – Can the option be dispatched to meet demand? The existing diesel generators can be dispatched to meet changes in demand as required.
- *Environmental Effects* – What are the major environmental effects associated with the option? The existing diesel generators produce emissions of NOx, SOx, CO, CO2, fine particulate matter, and unburned hydrocarbons (UHC). Aquatic effects include groundwater contamination due to fuel spills and the risk of spills during fuel transportation over winter roads.
- *Fuel Supply* – What are the fuel supply availability, transportation, storage, and handling issues associated with the option? The existing diesel generators have certainty of fuel supply availability, but significant transportation challenges associated with use of winter roads and spill and soil contamination risks associated with fuel storage and handling.

Options with equivalent or superior performance over these five parameters relative to the existing diesel generators were selected for further analysis.

The results of the technical and environmental screening exercise are presented in Table A1 below.

Table A1 – Technical & Environmental Screening Results

Option	State of Technological Development	Reliability & Maintainability	Dispatchability	Environmental Effects	Fuel Supply	Acceptable?
Solar Photovoltaics	Commercially available, mature. However, not yet considered practical for large scale applications.	Unproven in these service conditions	Not dispatchable. Must be used in combination with a dispatchable supply option.	**Terrestrial** large footprint **Air Quality** N/A **Aquatics** N/A **Noise** N/A	Not applicable	No
Hydrogen Based Thermal Generation (reciprocating gensets fired with hydrogen)	Research & Development	Unproven, but assumed to be similar to existing diesel gensets (~95% plant availability)	Dispatchable	**Terrestrial** small footprint **Air Quality** not significant **Aquatics** not significant **Noise** constant process noise	Significant challenges associated with fuel supply, transportation, storage, and handling.	No
Biomass Based Thermal Generation (boiler and steam turbine for power generation)	Commercially available, immature.	Reliability assumed to be similar to coal fired generation (~85% plant availability). Significant challenges associated with ensuring adequate on site technical expertise, part supply, and support staff. Significant challenges associated with access to OEM and contract expertise.	Dispatchable	**Terrestrial** medium footprint, land use required for storage of ash **Air Quality** emissions of NOx , SOx, and particulate matter, but assumed to be CO2 neutral **Aquatics** water withdrawal for process steam and cooling, potential liquid effluent depending on ash handling process, possible groundwater contamination risk and risk of spills during fuel transportation **Noise** constant process noise.	Uncertainty associated with supply availability. Backup fuel supply, such as diesel would be required to ensure adequate supply is available at all times. Significant transportation challenges associated with use of winter roads, significant storage and handling challenges in extreme cold service conditions.	No
Wind Generation	Commercially available, mature.	see GEC report for Alaska experience	Not dispatchable. Must be used in combination with a dispatchable supply option.	**Terrestrial** medium footprint, potential for bird strikes and disruption to wildlife due to noise **Air Quality** N/A **Aquatics** N/A **Noise** Minor process noise	Unknown. Wind resource data required.	Yes

Table A1 (con't) – Technical & Environmental Screening Results

Option	State of Technological Development	Reliability & Maintainability	Dispatchability	Environmental Effects	Fuel Supply	Acceptable?
Small Hydro Generation	Commercially available, mature	~95% Plant availability, proven maintainability in these service conditions, reliability could be subject to stream flows and water levels	Dispatchable	**Terrestrial** large footprint **Air Quality** N/A **Aquatics** oil spill potential, turbidity potential, fish effects **Noise** constant process noise	Minimal water storage, supply subject to local stream flows and levels. Dependent on site identification and selection, and potential design	No
Connection to Transmission Grid	Commercially available, mature	~95% availability, proven maintainability in these service conditions	Dispatchable	**Terrestrial** large footprint **Air Quality** N/A **Aquatics** N/A **Noise** N/A	Not applicable	Yes
Existing Diesel Generators	Commercially available, mature	~95% Plant availability , proven maintainability in these service conditions	Dispatchable	**Terrestrial** small footprint **Air Quality** emissions of NOx, SOx, CO, CO2, fine particulate matter, and unburned hydrocarbons (UHC) **Aquatics** no water withdrawal or effluent streams, possible groundwater contamination risk, risk of spills during fuel transportation **Noise** constant process noise.	Good supply availability, significant transportation challenges associated with use of winter roads, spill and soil contamination risks with storage and handling.	N/A

Based on the screening exercise, the following options were excluded from further consideration;

- *Solar photovoltaics* – this option was excluded because it is not yet considered practical for large scale applications, has unproven reliability and maintainability in extreme cold weather service conditions, and is not dispatchable. The current technology has a very low annual capacity factor (~8%). This would pose significant challenges to integrating this technology with the existing diesel generators while ensuring reliability of service. However, this option could be considered as a possible option for individuals to reduce residential electricity demand.
- *Hydrogen-Based Thermal Generation* – this option was excluded because it is still in the R&D phase of technological development and has significant uncertainty and challenges associated with the supply, transportation, storage, and handling of hydrogen in severe service applications.
- *Biomass-Based Thermal Generation* – this option was excluded on the basis of its greater air and aquatic effects relative to existing diesel generation, the significant challenges associated with the handling and storage of ash, and the significant maintenance challenges associated with operating a steam power plant in a remote location without year-round road access. Fuel supply is also a concern as there is not a sustainable local feedstock available, and there are significant challenges associated with long distance fuel transportation, long term storage, and fuel handling. However, the use of biomass fuel could be considered as a possible option to replace fuel oil for home heating.

- *Small Hydro Generation* – The small hydro development option has been screened out of this study due to a number of issues including: the need to identify an appropriate site for small hydro applications, limited local hydrometric data, the need for a feasible station design and associated cost estimates, limited water storage, unknown environmental impacts, reliability, minimal long term employment opportunities, and the Heritage River designation of the Hayes River. These issues need to be considered and resolved before small hydro development can be evaluated as an option for this community. This is not to say that the option will never be explored, but with these issues remaining an adequate evaluation cannot be performed.

  Although there are two sites within approximately 50km previously identified by Manitoba Hydro as having hydroelectric development potential, that potential was for large scale developments, and may not be suitable sites for small hydro development. Further study would be required to determine the adequacy of these sites for small hydro development. Table A2 below provides a summary of these sites:

Table A2 - Previously Identified Hydro Development Sites

Site Name	Head (m)	Potential Capacity (MW)
Rabbit Track River	12	68
Red Mud Rapids	15	69

Limited local hydrometric data is a significant reason why small hydro options have been excluded from study at this time. With the information currently available it is difficult to determine the potential for small hydro development, or to determine if local stream flows would be able to reliably supply the required dependable energy to the community well into the future.

In addition to stream flow data, water levels associated with the stream flows would be required to determine the developable head to provide dependable energy. High water levels associated with higher stream flow cases would also be required, as these levels could potentially wash out the tail water of a small hydro site if not properly designed, reducing the working head of the station, and diminishing generation capacity. This also could jeopardize the reliability of power supply to the community.

As a proxy for developable head requirements, data available from the Environment Canada HYDAT database for the nearest hydrometric measurement station to the community on the Gods River, near Shamattawa (site 04AD002), was evaluated for dependable supply. Records from this site are available from 1968 to 2006, during which the minimum monthly mean discharge recorded was 79.8m^3/s, and there was limited water level data available to determine any substantial range of flow depths at this site. Table A3 shows the estimated development head required under minimum stream flow conditions to serve the forecast community energy and capacity requirements at 60 and 200 Amp service at the end of the study period. These values were calculated assuming 88% hydraulic efficiency, and assuming 100% of minimum recorded stream flow is available for generation.

Table A3 - Development Head Requirements for 2042

	Forecast Requirements			
Service	Energy (MWh)	Head (m)	Capacity (kW)	Head (m)
60 Amp	14786	2.4	3293	4.8
200 Amp	21651	3.6	5841	8.5

If adequate hydrometric data were available for a potential development site, a station design that could serve the community needs well into the future is required, to ensure that the plant would minimally disrupt the local environment, allow for fish passage, and not inhibit traditional and recreational access through the area. Acceptable levels for these design parameters and others would also need to be established for design purposes. Once a design is established, cost estimates could be generated and analysis could be performed to determine the economic feasibility of the proposal. This also serves as a reason why small hydro development was not included in the supply options study at this time.

One important consideration for design that would need to be addressed is water storage. With a small hydro installation, it is likely that there would be only short term storage available with the weir design in order to minimize flow disruption, environmental impact, or traditional and recreational access. In terms of reliable energy supply, this leaves the community vulnerable to long term water shortages.

Small hydro development could also create a significant environmental impact depending on the channel geometry and hydraulic characteristics of a potential site, as well as the characteristics upstream and downstream of the site. In addition to station design work, studies of the potential impacts to the area would need to be completed if this option is to be realistically explored in the future.

During the evaluation of small hydro options for the Brochet and Lac Brochet study, the issues of reliability, limited socioeconomic benefit, and larger potential environmental impact incremental to existing diesel generation became evident. Reliability concerns would require maintaining the diesel generation facility to provide back-up generation for major unplanned outages, insufficient stream flows, and would be required for peak load service when community demand exceeds hydroelectric development potential at the station. Although community demand growth could be addressed by developing additional sites, if multiple sites exist, this raises the issue of excessive development and disruption to the natural environment. While reliability would be a concern under 60 Amp service, these concerns would be amplified under a 200 Amp service scenario.

The Brochet and Lac Brochet study also revealed that the potential employment opportunities outside of the construction period would likely be limited for a small hydro station. The diesel operator's position would still remain as the diesel generators would need to be maintained for reliability in the situations mentioned above.

On a purely economic basis, the small hydro option would be most advisably pursued for a 200 Amp supply option, due to the fact that the capital investment required would likely be a small increment compared to the cost of developing a station for 60 Amp service. However, it would also require an increased amount of diesel fired generation to be installed and maintained for reliability in the potential situations where diesel generation would still be needed as outlined above.

As discussed above, a small hydro site to serve Shamattawa would likely be proposed on the Gods River, a major tributary of the Hayes River. The Hayes River is a Canadian Heritage River that was designated in 2006 in recognition of its outstanding natural heritage, human heritage and recreational values. In the Management Plan for the Hayes River one of the management intents indicates water flows on the Hayes River will remain unaltered by human caused activities and, in particular, impoundments and diversions. As such, there would be sensitivities to proposing small hydro development on a river that is connected to and could affect a heritage river.

The options that were selected for further analysis are as follows;

- *Augmenting Diesel Generation with Wind Power.* This option can only reduce, not eliminate, diesel generation because it is not dispatchable and must therefore be used in combination with existing diesel generators to ensure a continuous, reliable supply of power.
- *Connection to the Transmission Grid.* This option has the ability to completely eliminate diesel generation at Shamattawa.

Appendix B - Summary of Assumptions

General Assumptions

- 6% real discount rate
- 2007 to 2042 study period (35 years)
- all costs in constant 2006 $CDN
- 2006 Manitoba Hydro 20 year delivered diesel price forecast for fiscal years 2006 to 2026. For the period beyond the forecast, 2027 to 2042, prices were held constant at their 2026 forecast values.
- 2.73 tonnes of CO2 are produced for each tonne of diesel burned

Load Forecast Growth Assumptions

Shamattawa

- 156 residential customers in 2007
  - residential growth of 2 houses per year assumed for both 60 amp and 200 amp service
- 45 general service customers in 2007
  - general service growth of 1 customer per year assumed for both 60 amp and 200 amp service

These assumptions apply to Manitoba Hydro's 2007 20 year load forecasts for 60 amp and 200 amp service (2007 to 2027). For the period beyond the forecast, 2028 to 2042, load growth of 2% per year was assumed for 60 amp service and load growth of 1% per year was assumed for 200 amp service. These percentage growth assumptions are based on average growth rates during the 2007 to 2027 forecast period.

Existing Diesel Generating Station Assumptions

Diesel Generator Replacement Cost
- $594 per kW, includes switchgear and installation
- based on Nov 2004 AMD Reciprocating Engine Power Services Process Review Final Report, AMD report no. AMD 2004-02

New Diesel Generator Capital Cost
- $891 per kW
- assumed new unit cost is 50% greater than replacement cost on a per kW basis

Non-Fuel Operating and Maintenance Cost
- $323,744 per year for Shamattawa
- based on 5 year average Manitoba Hydro SAP O&M order settlements

Diesel Generator Service Life
- 14 years
- based on the 2004/05 AMD North Diesel Generating Stations Report

Diesel Generator Thermal Efficiency
- 3.65 kWh per litre of diesel for Shamattawa
- based on the 2004/05 AMD North Diesel Generating Stations Report

Diesel Site Decommissioning Cost
- $3.0 million
- RPMA estimate based on thermal station decommissioning cost estimates

Wind Generation Assumptions

Wind Turbine Model
- Fuhrländer FL250
- 50 m tower height
- 29.5 m rotor diameter
- Based on the July 2006 Global Energy Concepts (GEC) report *Preliminary Analysis of Wind-Diesel Opportunities in Remote Manitoba Communities*

Wind Energy Penetration Rate
- 20% of annual energy demand
- Based on the July 2006 Global Energy Concepts (GEC) report *Preliminary Analysis of Wind-Diesel Opportunities in Remote Manitoba Communities*

In Service Dates

- Shamattawa – four turbines in 2013, a fifth turbine in 2020, a sixth turbine in 2027, and a seventh turbine in 2035. Also assumed a 425kW diesel generator in 2013 for better integration with wind generation operations.

Capital Cost

- $3335 per kW
- Based on the July 2006 Global Energy Concepts (GEC) report *Preliminary Analysis of Wind-Diesel Opportunities in Remote Manitoba Communities*
- Assumed GEC cost estimate plus 15% to account for access roads and transmission lines.

Operating & Maintenance Cost

- $28.75 per kW
- Based on the July 2006 Global Energy Concepts (GEC) report *Preliminary Analysis of Wind-Diesel Opportunities in Remote Manitoba Communities*
- Assumed GEC cost estimate plus 15% to account for additional challenges associated with remote maintenance.

Turbine Service Life

- 25 years
- consistent with Manitoba Hydro wind evaluation methodology

Regulatory Process Cost & Duration

- $250,000, internal process cost estimate
- process time less than one year

138 kV Transmission Assumptions

In Service Date: 2013

Capital Costs (based on 2005 Manitoba Hydro estimates)

- Transmission station = $16.58 million
- Transmission line = $34.68 million

Operating & Maintenance Costs (Manitoba Hydro estimates)

- Transmission station = $78,500 per year
- Transmission line = $141,729.69 per year
- Marginal cost of energy = $0.056/kWh assuming load is served from northern generation

Transmission Service Lives

- Transmission station = 35 years
- Transmission line = 50 years

- Consistent with Manitoba Hydro evaluation methodology

Transmission Line Distances (Manitoba Hydro estimates)

- Radisson Station to Shamattawa = 170 km

Regulatory Process Cost & Duration

- $600,000
- 2 year duration

Residential Heating Assumptions

N.E.M.A. formula inputs

- Heat Loss = 11.44
  - value for a 1000 sq. ft. bungalow with an unheated crawlspace
  - includes a 10% add-on for locations north of the 53rd parallel
- Constant = 14
  - Average for most homes
- Shamattawa Degree Days = 7600
  - Based on geographic location and indoor design temperature of 22°C
- Design Temperature Difference = 55°C
- Formula inputs based on values obtained from Manitoba Hydro's "Efficient Heating of Buildings Manual".

Oil Heating Systems

- Energy per litre of oil = 10.611 kWh
  - Based on 38.2 MJ/litre obtained from "Heating with Oil", available from Natural Resources Canada
- Vented space heater efficiency = 60%
- Forced air furnace efficiency range = 60 to 89%
  - Range covers a variety of potential furnace installations
- Fuel Oil heating efficiencies based on values obtained from "Heating with Oil", available from Natural Resources Canada
- Shamattawa 2006 Fuel Oil price = $1.07
- 2006 Fuel Oil Prices based on 2006 Manitoba Hydro 20 year delivered diesel price forecast for fiscal years 2006 to 2026

Electric Baseboard Heating

- Residential Rate Energy Charge = $0.05654
- Based on information obtained from Manitoba Hydro's Customer Policy Application Website

Manitoba
Hydro

820 Taylor Ave (4) • Winnipeg Manitoba Canada • R3M 3T1
Telephone / N° de téléphone : (204) 474-4796 • Fax / N° de télécopieur : (204) 474-3102
bburdett@hydro.mb.ca

2008 10 17

Chief and Council
Barren Lands First Nation
General Delivery
Brochet, MB R0B 0B0

Dear Chief and Council:

OUTSTANDING ISSUES FROM AUGUST 28,2008

Included with this letter are draft minutes from our August meeting. I am including responses to the outstanding questions from the minutes as follows:

> The contacts for Customer Service are 1-888-MB-Hydro. During regular working hours the system will direct the calls to the appropriate District Office. After hours if you call you can ask to have someone from the District Office return your call the next working day.
>
> Billing inquiries are done through Customer Service (above)
>
> Manitoba Hydro offers homeowners, Power Smart financing up to $7500.00 per residence at an interest rate of 6.5% and a maximum term of 60 months. Loan applicants must have approved credit from Manitoba Hydro prior to proceeding with their renovation and the upgrade must meet the current Power Smart levels recommend by Manitoba Hydro. In instances where the Band or First Nation is the owner of the home it must act as the applicant and would be required to meet the same requirements, including credit requirements, as a homeowner.
>
> Power Smart Program representative for your area is Ed Cook and he can be reached in Thompson @ 1-204-778- 0134.
>
> Funding requests for community events are handled by Donna Minkus @ 444 St. Mary, R3C 3T7, she can be reached @ # 1-204-480-5230.
>
> The First Nation Accounts Manager is Michel Morin and he can be reached @ 1-204-480-5620.

If there are any more questions feel free to call me any time. I can be reached @ # 1-204-471-3025 or faxed @ # 1-204 474- 3102. We look forward in hearing more of your feedback from the Screening Study presentation.

Yours truly,

Blair Burdett
Aboriginal Liaison Officer

BB/bb/Final response letter to Barrens Land.doc

Manitoba Hydro
820 Taylor Ave (4) • Winnipeg Manitoba Canada • R3M 3T1
Telephone / *N° de téléphone :* (204) 474-4796 • Fax / *N° de télécopieur :* (204) 474-3102
bburdett@hydro.mb.ca

2008 10 17

Mayor and Council
Brochet Community Council
General delivery
Brochet, MB R0B ON0

Dear Mayor and Council:

OUTSTANDING ISSUES FROM AUGUST 28,2008

Included with this letter are draft minutes from our August meeting. I am including responses to the outstanding questions from the minutes as follows:

> The contacts for Customer Service are 1-888-MB-Hydro. During regular working hours the system will direct the calls to the appropriate District Office. After hours if you call you can ask to have someone from the District Office return your call the next working day.
>
> Billing inquiries are done through Customer Service (above)
>
> Manitoba Hydro offers homeowners, Power Smart financing up to $7500.00 per residence at an interest rate of 6.5% and a maximum term of 60 months. Loan applicants must have approved credit from Manitoba Hydro prior to proceeding with their renovation and the upgrade must meet the current Power Smart levels recommend by Manitoba Hydro. In instances where the Band or First Nation is the owner of the home it must act as the applicant and would be required to meet the same requirements, including credit requirements, as a homeowner.
>
> Power Smart Program representative for your area is Ed Cook and he can be reached in Thompson @ 1-204-778- 0134.
>
> Funding requests for community events are handled by Donna Minkus @ 444 St. Mary, R3C 3T7, she can be reached @ # 1-204-480-5230.
>
> The First Nation Accounts Manager is Michel Morin and he can be reached @ 1-204-480-5620.

If there are any more questions feel free to call me any time. I can be reached @ # 1-204-471-3025 or faxed @ # 1-204 474- 3102. We look forward in hearing more of your feedback from the Screening Study presentation.

Yours truly,

Blair Burdett
Aboriginal Liaison Officer

BB/bb/Final response letter to Brochet Community Council.doc

Manitoba Hydro, Barren Lands First Nation, and Brochet Community Council
Meeting Minutes

August 28, 2008

Present: Barren Lands First Nation
Chief Russell Halkett
Councilor John Bighetty
Councilor Darlene Clarke
Elder Philip Bighetty

Brochet Community Council
Mayor David Laponsee
Councilor Ralph Marasty
Councilor Adolph Cook
Councilor Robert Merasty

Aboriginal and Northern Affairs
Cory Young

Manitoba Hydro
Blair Burdett - Aboriginal Liaison Officer, Aboriginal Relations Division
Brad Johnson - Resource Evaluation, Power Planning Division
Jim Birrell - AMD-North Manager, Apparatus Maintenance Division
Larry Karatchuk - Aboriginal Relations Division
Mark Reimer - District Operator, Customer Service Operations Division
Ken Thomas - Fleet Services Manager, Distribution Construction Division

Next meeting: Yet to be determined.

I. Introductions and Expressions of Thanks

Introductions were completed.

The purpose of the meeting is to provide a presentation to Chief and Council, and Mayor and Council on Alternative Energy Options for the community of Brochet and also to address any other concerns which may arise. These high level studies for options of power supply are being shared with the intent of getting people from all sides of the issue talking and gaining input on what direction they wish to pursue. Manitoba Hydro did not provide a recommendation in these studies. Barren Lands First Nation, Brochet Community Council, and Indian and Northern Affairs Canada (INAC) must decide on how they wish to proceed and how to provide the required funding for further study.

The Aboriginal Relations Division is involved in this process in acting as Liaison.

Blair Burdett of Manitoba Hydro thanked Chief and Council for welcoming MH staff in the community to allow for an opportunity to share the presentation.

Copies of the following were made available to Chief and Council, and Mayor and Council:

Draft - Generation Resource Screening Study

Handout PPS - Community Power Supply Options

II. Opening Prayer

Elder Philip Bighetty started the meeting with an opening prayer.

III. Presentation - Community Power Supply Options and Concerns Expressed

1) ENERGY Efficiency / DSM Programs

Discussion on need to offer access to energy efficiency programs to assist with reducing energy use. Manitoba Hydro to follow-up by providing contacts for energy efficiency and DSM programs to the communities.

2) 60 vs. 200 Amp

No discussion outside of presentation content.

3) Transmission Line

Chief and Council asked if it would have been cheaper to build a transmission line when the new diesel plant was built (in service in 1999). Manitoba Hydro staff stated that, with project costs and fuel prices at the time, diesel generation was the most economic option.

Chief and Council asked about the possibility of a transmission line from Sandy Bay Saskatchewan, a distance of about 150 km. Manitoba Hydro staff replied that, for about the same distance, Manitoba Hydro would look at a line from Lynn Lake first. SaskPower informed Manitoba Hydro that the existing transmission into Northern Saskatchewan does not have enough capacity to supply the communities of Brochet, Lac Brochet and Tadoule Lake. Any Transmission line built would have to serve all three.

Chief and Council asked if the route from South Indian Lake was looked at. The existing transmission to South Indian Lake is also too small to supply communities of Brochet, Lac Brochet and Tadoule Lake. Chief and Council asked about the dam at South Indian Lake (Missi Falls), if a transmission line could be run from there. Manitoba Hydro staff explained that Missi Falls is a control structure, used to regulate water levels on the lake. It has a small house unit that generates power for station service, but is not enough for transmission to these communities.

Members of Chief and Council stated that the transmission line is the way to go, that no water should be disturbed and wind power is not likely to work.

Manitoba Hydro staff explained the impact on bills that a transmission line with 200 Amp service would have. As with the North Central project, if rates go down to grid rates, but electricity use rises for electric heating, the total electric bill will go up for most customers.

4) Mini / Small Hydro

Chief and Council indicated that Small Hydro will never happen in their community, that if any hydro generation happens in Barren Land's territory, it will be them that does it. The community is still dealing with issues from effects of past hydro development.

Questions were asked about turbines installed in the river bed, without building a dam or weir. Chief and Council referred to one of these installations they had visited in Ontario that seemed to work well. Manitoba Hydro staff stated that concerns such as river ice may be an issue with these types of generators and that more information is needed on how they operate in Northern Manitoba settings. Manitoba Hydro staff also explained the research that Manitoba Hydro is involved in with the kinetic turbines at Pointe du Bois.

Members of Chief and Council expressed concern that small hydro generation will affect water in some way, and that it is better to have transmission lines. There is a possibility that there will be an all-weather road some day, which will bring more small business opportunities to the community.

5) Wind
Manitoba Hydro staff explained the process for evaluating wind sites. Test towers are put up to collect wind data, and there has to be a strong enough wind for a certain percentage of time throughout the year to make a site worth developing wind turbines. The wind development at St. Leon is operating above 40% of its capacity.

Chief and Council stated that we can not guarantee that there will be wind to generate power.

6) Ownership / Burden of cost
Manitoba Hydro staff explained that if any of these alternatives were to be implemented, that there would have to be INAC funding for a major portion of the costs.

7) Other
Chief and Council indicated that the Band is having some problems with community members having high Hydro bills. Manitoba Hydro staff replied that some of these are an indication that there are heaters hooked up - sometimes, not for long, maybe just to take the chill off in the morning or in the evening. Portable air conditioners can have the same effect in the summer. If these things put a customer's energy use over 2000kWh in a month, the higher rate starts. As well, the weather was bad in March and there was difficulty getting in for meter reads. Some of the bills had to be readjusted and there are a small number yet to be fixed. This may be part of the reason for high bills.

Chief and Council stated that the Band did some investigating and these people were Elders, and did not use that much hydro. A strong concern is that these people are trying to live on a pension, a large amount of which goes to pay the hydro bills. Manitoba Hydro staff indicated that they were aware of at least one of these accounts, and that meter read had been cleared up. Chief and Council indicated that there are still others. Manitoba Hydro staff explained their understanding that sometimes people gather at an Elder's house for family meals or gatherings, which uses more electricity for hot water and food preparation. This would result in more hydro for the Elder who is trying to get by on a pension. There was agreement that this could be a reason for higher bills.

Chief and Council asked if there was such a thing as an Elder's rate for Hydro. Manitoba Hydro staff stated that there was not.

Mayor and Council stated that the community needs options for heat for the Elders, without destroying their land in the process, and thought that maybe the transmission line would be more environmentally friendly than other options discussed.

Mayor and Council asked if Manitoba Hydro ever has trouble with faulty meters. Manitoba Hydro staff stated that they had no first-hand knowledge of this happening, but that does not mean it cannot happen. Chief and Council brought up a customer whose meter never stops. Manitoba Hydro staff explained that sometimes it could be something as simple as a fridge compressor getting old and trying to keep the fridge cool, or an old washer. The older the appliance is, the harder it has to work. There is usually an explanation for this.

Chief and Council asked what uses the most electricity in a home. Manitoba Hydro staff replied that most likely hot water heaters and washers and dryers used the most.

Chief and Council stated that there are limitations to some of the other power supply options screened out, that solar energy does not work in some cases. There was some interest in a better explanation of what is considered biomass fuel and how biomass generation works, which Manitoba Hydro staff provided.

Chief and Council stated that consultants that they have spoken to have a different view of some of these options, they think that some are money makers.

Chief and Council suggested showing this presentation to the community would be a good idea, so they can see what is being discussed. Manitoba Hydro staff stated it could be possible to do that.

8) Bio-Diesel Pilot Project

Manitoba Hydro staff spoke briefly on the bio-diesel pilot project at the Brochet diesel generating station. This included an explanation of what bio-diesel is and how the pilot project will work.

9) Items for Follow-up

The next steps will include an opportunity to add more of Chief and Council, and Mayor and Council's feedback on this meeting and could be added to the minutes. These meetings will continue to assist in a decision being moved forward.

Manitoba Hydro to provide a list of contacts to the communities for the following areas:

- customer service
- Power smart/DSM
- billing inquiries
- funding for community events
- First Nations Account Manager

IV. Closing Prayer

Elder Philip Bighetty gave the closing prayer.

Manitoba
Hydro

820 Taylor Ave (4) • Winnipeg Manitoba Canada • R3M 3T1
Telephone / *N° de téléphone* : (204) 474-4796 • Fax / *N° de télécopieur* : (204) 474-3102
bburdett@hydro.mb.ca

2008 10 17

Chief and Council
Northlands Dene First Nation
General Delivery
Lac Brochet, MB R0B 2E0

Dear Chief and Council:

OUTSTANDING ISSUES FROM JUNE 24,2008

Included with this letter are draft minutes from our June meeting. I am including responses to the outstanding questions from the minutes as follows:

> The original BCR agreement dated November 1980 is included with this letter.
>
> The contacts for Customer Service are 1-888-MB-Hydro. During regular working hours the system will direct the calls to the appropriate District Office. After hours if you call you can ask to have someone from the District Office return your call the next working day.
>
> Power Smart Program representative for your area is Ed Cook and he can be reached in Thompson @ 1-204-778- 0134.
>
> Billing inquiries are done through Customer Service (above)
>
> Funding requests for community events are handled by Donna Minkus @ 444 St. Mary, R3C 3T7, she can be reached @ # 1-204-480-5230.
>
> The First Nation Accounts Manager is Michel Morin and he can be reached @ 1-204-480-5620.
>
> There is no activity with regards to a Nunavut Power Line at this time.
>
> In regards to ownership of distribution lines within the community, Manitoba Hydro would be willing to discuss any First Nation proposal provided that Manitoba Hydro's investment in the assets is recouped.

If there are any more questions feel free to call me any time. I can be reached @ 3 1-204-471-3025 or faxed @ # 1-204 474- 3102. We look forward in hearing more of your feedback from the Screening Study presentation.

Yours truly,

Blair Burdett
Aboriginal Liaison Officer

BB/bb/Final letter of reponse to Lac Brochet.doc

Manitoba Hydro and Northlands Denesuline First Nations
Meeting Minutes

June 24, 2008

Present:	Northlands First Nation Chief Joe Danttouze Councilor Joe Hyslop Councilor Nap Denechezhe Councilor Lena Sha"oullie * Councilor Matilda Denttanikkeaze * Band Manager, Eleanor Veulliot*
	UpNorth Consulting Group Ltd. Rick Bushey, Co-Manager
	Manitoba Hydro Blair Burdett - Aboriginal Liaison Officer, Aboriginal Relations Division Brad Johnson - Resource Evaluation, Power Planning Division Jim Birrell - AMD-North Manager, Apparatus Maintenance Division Carol Lussier - Administrative Representative, AMD-North
Next meeting:	Yet to be determined.

* portion of meeting only

I. Introductions and Expressions of Thanks
Introductions were completed.

The purpose of the meeting is to provide a presentation to Chief and Council on Alternative Energy Options for the community of Lac Brochet and also to address any other concerns which may arise. These high level studies for options of power supply are being shared with the intent of getting people from all sides of the issue talking and gaining input on what direction they wish to pursue. Manitoba Hydro did not provide a recommendation in these studies. Northlands First Nation and Indian and Northern Affairs Canada (INAC) must decide on how they wish to proceed and how to provide the required funding for further study.

The Aboriginal Relations Division is involved in this process in acting as Liaison.

Blair Burdett of Manitoba Hydro thanked Chief and Council for welcoming MH staff in the community to allow for an opportunity to share the presentation.

Chief Joe Danttouze also thanked Manitoba Hydro for coming to share the presentation.

Copies of the following were made available to Chief and Council:

Draft - Generation Resource Screening Study
Handout PPS - Community Power Supply Options

11:45 - break for Lunch. Meeting to resume at 1:00 p.m.

II. Opening Prayer

Meeting resumed at 1:20 p.m.

Chief Joe Dantouzze spoke to the purpose of prayer before commencing a meeting, and then continued with leading the Lord's Prayer.

III. Presentation - Community Power Supply Options and Concerns Expressed

1) ENERGY Efficiency / DSM Programs

Chief and Council raised on a question on energy efficiency programs. Manitoba Hydro came in once and provided the efficient light bulbs: Is there more that can be done here?
Manitoba Hydro to follow-up by providing contacts for energy efficiency and DSM programs to the communities.

2) 60 vs. 200 Amp

Chief and Council expressed concern that 60 amp is currently not enough with the push of technology causing increased demand and breaker overloads in their community.

3) Transmission Line

Chief and Council asked what the status is of the Nunavut Power feasibility studies. Manitoba Hydro will provide the status of the Nunavut power line feasibility studies.

Chief and Council stated that they would like to delay some decisions pending land claims settlement. If there is development pertaining to a Nunavut or Tadoule Lake Power Line, and the lines cross Northlands Denesuline land, Land Claims would have to be considered.

Comment made by Chief and Council that a transmission line option would provide for opportunity to tie in a road. There was general agreement that the road would certainly address isolation issues facing the community but would come with a high cost.

4) Mini / Small Hydro

Question raised by Chief and Council as to why no study was completed on Micro Hydro. Smaller hydro options have not yet been proven in Northern Manitoba conditions, where issues such as the effects of ice need to be understood. The University of Manitoba and Manitoba Hydro are working together on studies on kinetic turbines at Pointe du Bois.

The question was raised while discussing community's plans for hydro-electric generation as to whether or not Manitoba Hydro would allow use of, and who would maintain, distribution lines in the community. Existing distribution is owned and maintained by Manitoba Hydro. It is too early in the process to comment on the issue, but options could be explored as to how the distribution might be dealt with if the community started to produce its own power. This would have to be discussed when more information on such a project is available. Manitoba Hydro to provide a description of the current policies/laws regarding ownership of distribution lines and supply of retail power in Manitoba.

Chief and Council asked how Manitoba Hydro could assist with a hydro-electric option. Manitoba Hydro could provide the names of Engineering Firms that have the expertise to assist Northlands Denesuline. There is also potential to offer in-house expertise.

Discussion on Micro-hydro highlighted that there are fewer environmental effects than Small Hydro, but more operational problems anticipated. The example was given that surface ice may inhibit operation of micro generation to a greater degree than it does Small Hydro. Any hydro option would have to be studied further for suitability in these conditions with respect to remoteness, water resources, operations, etc.

5) Wind
No comment or discussion beyond presentation material.

6) Ownership / Burden of cost
Chief and Council stated a desire for the community to own a hydro-electric option if pursued.

INAC funding is required for any project, and Chief and Council see an opportunity for the community to benefit from projects.

Chief and Council commented that it was unfortunate that INAC was not able to attend the meeting as it would be good to have them as part of these discussions.

7) Other
Chief and Council requested a copy of the original BCR of the agreement between Manitoba Hydro and the Band. Manitoba Hydro staff to follow up on this request.

Chief and Council remarked on economic development, future generations, business in the community and how to make things work, bring parties together, put plans into action. Since 2004 Lac Brochet has been involved in studies on Micro-hydro. The members of Lac Brochet need socio-economic development to survive and they believe that it can be done and it takes working together. A transmission line may be a good idea with the cost of living, remoteness, and the potential of having an all weather road. Micro-hydro could be built, but it is good that Manitoba Hydro has studies and information is being shared. There was acknowledgement that these things do not happen quickly. Parties working together make things happen. It is important for the community to work within their land and there is potential to go a long way if all parties start working together.

There was a request as to whether or not Manitoba Hydro might provide funding for community events. Contact information was provided and will be included in a list of contacts to be provided to the community.

Chief and Council expressed concern that First Nation accounts, Social Assistance in particular, are being charged a surcharge. They also noted their understanding that there would no longer be a requirement to pay the surcharge in the tentative settlement reached where rates have been restructured. Federal dollars are provided up-front, to Northlands Denesuline, for these expenses. Northlands Denesuline is then responsible for payment to Manitoba Hydro and the Federal dollars provided should cover the surcharge. Manitoba Hydro staff commented that it appears that clarification between Chief and Council, UpNorth Consulting, and INAC is required in this regard.

Chief and Council commented that there is a need to look at 35 years from now. There is a need to have more discussions, the First Nations and Manitoba Hydro need to negotiate. It's best to work together and establish a common ground and vision - there is a potential for both parties to benefit.

Chief and Council brought forward the arena problems as an example of issues facing the community. The community wants the same opportunities that other communities, southern communities, have - such as use of an arena with artificial ice year-round. The community can barely keep it going and has to shut it down in the summer due to the cost of maintaining the ice. There are obstacles and a need to plan and to agree on something to address them.

Chief and Council commented that Manitoba Hydro's presentation was good and a real eye opener.

8) Items for Follow-up

The next steps will include an opportunity to add more of Chief and Council's feedback on this meeting and could be added to the minutes. These meetings will continue to assist in a decision being moved forward.

Manitoba Hydro staff to obtain a copy of the original BCR of the agreement between Manitoba Hydro and the Band.

Contact Customer Service to re-establish contact for Power Smart programs available to the community.

Manitoba Hydro to provide a list of contacts to the communities for the following areas:

- customer service
- Power smart/DSM
- billing inquiries
- funding for community events
- First Nations Account Manager

Manitoba Hydro to provide the status of the Nunavut power line feasibility studies.

Manitoba Hydro to provide a description of the current policies/laws regarding ownership of distribution lines and supply of retail power in Manitoba.

IV. Closing Prayer

Chief Joe Danttouze led closing prayer.

Meeting adjourned at 3:30 p.m.

Manitoba Hydro

820 Taylor Ave (4) • Winnipeg Manitoba Canada • R3M 3T1
Telephone / *N° de téléphone* : (204) 474-4796 • Fax / *N° de télécopieur* : (204) 474-3102
bburdett@hydro.mb.ca

2008 10 17

Chief and Council
Sayisi Dene First Nation
General Delivery
Tadoule Lake, MB
R0B 2C0

OUTSTANDING ISSUES FROM JUNE 25,2008

Included with this letter are draft minutes from our June meeting with the previous Chief and Council and Ramona Tkachuk. I am including responses to the outstanding questions from the minutes as follows:

> The contact for Customer Service is 1-888-MB-Hydro. During regular working hours the system will direct the calls to the appropriate District Office. After hours if you call you can ask to have someone from the District Office return your call the next working day.
>
> Billing inquiries are done through Customer Service (above)
>
> Power Smart Program representative for your area is Ed Cook and he can be reached in Thompson @ 1-204-778- 0134.
>
> Manitoba Hydro offers homeowners, Power Smart financing up to $7500.00 per residence at an interest rate of 6.5% and a maximum term of 60 months. Loan applicants must have approved credit from Manitoba Hydro prior to proceeding with their renovation and the upgrade must meet the current Power Smart levels recommend by Manitoba Hydro. In instances where the Band or First Nation is the owner of the home it must act as the applicant and would be required to meet the same requirements, including credit requirements, as a homeowner.
>
> Funding requests for community events are handled by Donna Minkus @ 444 St. Mary, R3C 3T7, she can be reached @ # 1-204-480-5230.
>
> The First Nation Accounts Manager is Michel Morin and he can be reached @ 1-204-480-5620.

There is no activity with regards to a Nunavut Power Line at this time.

The water treatment lift station was being billed incorrectly. The account is being adjusted back to April 1, 2006. We have discussed financial details with your Co-Manager (Ramona Tkachuk) at a November 6 meeting and are definitely willing to meet with Chief and Council on this matter if further discussion is necessary.

Customers with accounts that are in good standing are eligible for the equal payment plan (EPP). This enables the customer to budget their electricity by paying equal monthly instalments. The program runs for 12 months beginning in September and ending in August. The customer's monthly energy costs are determined by previous usage. Monthly instalment amounts may be revised (as actual usage accumulates) to better balance at the end of the term. Regular meter readings are necessary for accurate usage information.

There was a question that came up about Manitoba Hydro billing house numbers instead of customers in a particular house. This should not happen unless the First Nation Band is being billed for that house meter and the new person that enters the house does not call Manitoba Hydro and let them know that they are a in fact a new resident in that house .

The street light concern about some of them being located where there are no houses will be looked at by our Customer Service staff.

If there are any more questions feel free to call me any time. I can be reached @ # 1-204-471-3025 or faxed @ # 1-204 474- 3102. We look forward in hearing more of your feedback from the Screening Study presentation.

Yours truly,

Blair Burdett
Aboriginal Liaison Officer

BB/bb/Final Response letter for meeting in Tadoule june 25 2008.doc

Manitoba Hydro & Sayisi Dene First Nation
Meeting Minutes

June 25, 2008

Present: Sayisi Dene First Nation
Councilor Corinna Powderhorn
Gladys Powderhorn - Finance & Administration

Sayisi Dene First Nation Co-manager
Ramona Tkachuk - Chartered Accountant

Manitoba Hydro
Blair Burdett - Aboriginal Liaison Officer, Aboriginal Relations Division
Brad Johnson - Resource Evaluation, Power Planning Division
Jim Birrell - AMD-North Manager, Apparatus Maintenance Division
Carol Lussier - Administrative Representative, AMD-North

Next meeting: Yet to be determined.

I. Introductions & Expressions of Thanks

Introductions were completed.

The purpose of the meeting is to provide a presentation to Chief and Council on Alternative Energy Options for the community of Tadoule Lake and also to address any other concerns which may arise. These high level studies for options of power supply are being shared with the intent of getting people from all sides of the issue talking and gaining input on what direction they wish to pursue. Manitoba Hydro did not provide a recommendation in these studies. Sayisi Dene First Nation and Indian & Northern Affairs Canada (INAC) must decide on how they wish to proceed and how to provide the required funding for further study.

The Aboriginal Relations Division is involved in this process in acting as Liaison.

Blair Burdett of Manitoba Hydro thanked Council representatives for welcoming MH staff in the community to allow for an opportunity to share the presentation.

Copies of the following were made available to Chief & Council:

Draft - Generation Resource Screening Study
Handout PPS - Community Power Supply Options

II. Presentation - Community Power Supply Options & Concerns Expressed

1) ENERGY Efficiency / DSM Programs

Council representatives commented that they have been receiving high bills for the church which is hardly used. Manitoba Hydro staff indicated that if the community is interested having energy audits conducted on community buildings, Manitoba Hydro would certainly be willing to explore this. Manitoba Hydro to follow-up by providing contacts for energy efficiency and DSM programs to the communities.

Council representatives inquired whether or not Power Smart loans were available to First Nations accounts. Manitoba Hydro staff is to provide policy information on Power Smart loan options available.

2) 60 vs. 200 Amp

Council representatives inquired as to what the costs would be to change from 60 to 200 AMP and who would be responsible for these costs. Manitoba Hydro staff responded that costs would likely be approximately $3,000 - $5,000 per house, but actual estimates would be required. Manitoba Hydro, via project funding, would upgrade conductors and transformers in the community. The change from 60 to 200 AMP would be an individual customer choice and could possibly be funded through INAC.

There was general discussion on 200 AMP and the availability of more electricity in homes. Manitoba Hydro staff noted that electricity bills would go up based on usage. In making a choice to convert to 200 AMP, the customer would need to consider the cost of overall energy use, including heating, and decide what their better option is.

Council representatives expressed interest in knowing the trade off for INAC to have the community off of diesel rates and onto electric heat at grid rates instead of heating with fuel oil. Manitoba Hydro staff stated that this question should be directed toward INAC

3) Transmission Line

Council representatives requested clarification on whether or not Manitoba Hydro is recommending the Transmission Line. Manitoba Hydro is not putting forth a recommendation; rather sharing information compiled in the studies.

Community representatives asked if Manitoba Hydro was promoting the Transmission Line so more money could be made by Hydro. Manitoba Hydro staff explained that with the current diesel generation, Manitoba Hydro makes no net profit on the diesel communities and only recovers costs. Manitoba Hydro is not making a recommendation as to what option should be pursued - this would be for the community and INAC to discuss further.

Manitoba Hydro staff restated that with the 200 AMP transmission line option, the cost of customers converting to 200 AMP has been excluded. As the decision to change from 60 to 200 Amp is an individual customer's choice, it is difficult to estimate how many homes would change or when.

Manitoba Hydro staff noted that the Transmission Line option would not proceed without Brochet and Lac Brochet due to concerns over cost and length of the line to serve only one of these three communities.

Council representatives asked how long the construction of a line would take. Manitoba Hydro staff replied that the study assumes two-year construction period for 160km of transmission line from Lac Brochet to Tadoule Lake.

Council representatives mentioned previous discussion of a transmission line option has brought up concerns with the caribou herds and affecting migration between Lac Brochet and Tadoule Lake.

Council representatives asked about the Transmission Line and Road to Nunavut feasibility study and whether or not Tadoule Lake may have an option to tie into that transmission line. The question was also raised as to whether or not Manitoba Hydro has been in discussions with Infrastructure and Transportation (formerly Department of Highways) on this. Manitoba Hydro is to provide the status of the Nunavut power line feasibility studies and discussions with the department of Infrastructure and Transportation.

Council representatives asked if a Transmission Line option would result in grid rates for all customers in the four diesel communities, subject to the same rate increases as the rest of Manitoba Hydro's customers. Manitoba Hydro answered that the transmission line would likely result in grid rates, and that potential rate structures could be addressed in future discussions.

Council representatives asked what becomes of the water & sewer return line (heat recovery program) if a transmission line is constructed. Manitoba Hydro staff commented that heat tracer wire would need to be installed on the water lines to prevent freezing.

4) Mini / Small Hydro

Council representatives requested an explanation of the Small Hydro option studied for Lac Brochet. Manitoba Hydro staff gave a brief overview of the design and operation of the Small Hydro option considered.

Council representatives asked whether this would provide enough power supply to the community of Lac Brochet. Manitoba Hydro responded that the study indicates that small hydro would provide sufficient power for the communities of Lac Brochet and Brochet during normal flow periods, but during low flow periods, diesel support might be required. Manitoba Hydro staff restated that although small hydro options were screened out of this study for Tadoule Lake, this does not mean that the option could never be studied. The option was screened out due to technical issues identified in the report and due to a lack of information on the suitability of small hydro on nearby streams. More information and funds are required in order to pursue a study.

5) Wind

Manitoba Hydro staff asked whether or not Manitoba Hydro could access information being collected at the Test Wind Tower, stating that this may require a Band Council Resolution (BCR) from the band. Council representatives stated that there should not be any problem with this, and that the collection of data is done through the Centre for Indigenous Environmental Resources (CIER).

6) Ownership / Burden of cost

Council representatives asked who would be responsible for capital investments: would it be the community itself? Manitoba Hydro responded that INAC is involved with capital projects attached to diesel generation and that INAC should be involved in any discussions regarding capital investments in the community.

Council representatives asked if Manitoba Hydro would look at cost sharing in capital costs. Manitoba Hydro staff replied that capital funding could come from a combination of INAC, and the Province of Manitoba, with some funding maybe from Manitoba Hydro. The North Central Project could potentially be used as a model for sharing costs.

Council representatives inquired if Manitoba Hydro has approached INAC on these studies. Manitoba Hydro indicated that there are very early discussions with INAC, and also that the community is to approach INAC to discuss potential options as they are, collectively, the customer.

Council representatives asked who would own the transmission line. Manitoba Hydro staff replied that, as with North Central, the transmission line option would be owned by Manitoba Hydro and that Manitoba Hydro would be responsible for the maintenance costs involved.

Council representatives asked whether or not Tadoule Lake could build the transmission line and lease it back to Manitoba Hydro. Manitoba Hydro responded that as Manitoba Hydro is a Crown Corporation owned by the province there may be some issues with that concept. Manitoba Hydro is to provide a description of the current policies/laws regarding ownership of distribution lines and supply of retail power in Manitoba.

7) Other

Council representatives asked about the drivers of these studies. Manitoba Hydro staff replied that interest from the Province regarding CO2, the PUB would also like to understand any alternate supply options, and recent legislation on green house gas emissions have all encouraged these studies and discussions. Manitoba Hydro's needs to plan for power supply for all communities in Manitoba also provide a need for studying power supply options in diesel communities.

Council representatives inquired on average kWh usage for a house in Manitoba. Manitoba Hydro staff replied that 1,000 kWh per month or 15,000 kWh per year is average use for a home in Manitoba without electric heat. The May 2008 Electric Load Forecast states that the average Standard customer (no electric heat) uses 10,800 kWh per year.

Council representatives explained an issue with the account for Tadoule Lake's Water Treatment Plant, wondering why it had gotten linked with Education rates. They explained that the lift station was originally set up for the teacherage, but now services the community water supply. INAC no longer funds this 100% as it is not only for education. There is a concern that this item should be under the General Service Residential rate and not as an education account as it presently is. Community Representatives stated that, if this account has been charged at a rate higher than it should have, the overcharge would be retroactive through the past two years. Manitoba Hydro to investigate this account and establish a contact for such inquiries.

There was general discussion on the formula that INAC uses to fund education accounts. Community representatives clarified that the funding is determined by expected usage based the square footage of the buildings, not the actual usage reflected in the bills. The council representatives expressed concern that this formula does not cover the amount reflected in the bills.

Council representatives inquired as to who is responsible for street lights. It seems that there are street lights situated where there are no houses. Manitoba Hydro staff stated that these streetlights could be relocated as required by the Lynn Lake District staff. Manitoba Hydro to follow up on this item.

Council representatives related a situation in which an unauthorized individual made a call after hours to Manitoba Hydro indicating that a customer was moving and to change the customer's rate to Education Authority. This resulted in a two month elevated hydro bill - should the customer be responsible for this? There has been difficulty in addressing these types of issues. Who should be contacted and what is the course of action for such cases? Manitoba Hydro staff indicated that when wanting to communicate with Hydro about First Nation accounts it could be safer to use email via the Manitoba Hydro website. Manitoba Hydro to establish and provide contacts on billing issues for the community.

Council representatives commented that they are in receipt of electricity bills for residences that are unoccupied. The bills reference the residences by house numbers, but the actual houses are not physically numbered so it is not easy to figure out which houses the bills belong to. Are there maps with meter tags or other identifying information that might be made available to assist with this? Manitoba Hydro to follow up on this.

Council representatives asked whether or not the First Nation might explore Equal Payment Plan (EPP) for accounts that are in good standing, as this could help customers regularly budget for and pay bills. Manitoba Hydro to follow up with First Nation's Account Manager on these items.

Community representatives stated that there has been a BCR for an all weather road from Lynn Lake.

There was general discussion on the need to identify or establish contacts for the communities for billing concerns, or for DSM programs. Manitoba Hydro will provide a list of contacts to the communities.

Council representatives expressed concern over the community's ability to catch up with payments when there is a fuel shortage in a year. If the community uses part of the next year's funding to pay for having to borrow fuel, it is then short on funds as the remaining funds do not cover the cost of next year's fuel needs. This becomes a cycle that is hard to break once it starts.

Meeting was adjourned at 3:30 p.m.

8) Items for Follow-up

The next steps will include an opportunity to add more of Chief and Council's feedback on this meeting and could be added to the minutes. These meetings will continue to assist in a decision being moved forward.

In terms of next meeting date, this is yet to be determined - looking at early fall.

Provide a list of contacts to the communities for the following areas:

- customer service
- Power smart/DSM
- billing inquiries
- funding for community events
- First Nations Account Manager

Manitoba Hydro staff is to provide policy information on Power Smart loan options available.

Manitoba Hydro to provide the status of the Nunavut power line feasibility studies and discussions with the department of Infrastructure and Transportation.

Manitoba Hydro to provide a response to ownership of transmission line. *Manitoba Hydro would own any major transmission lines. It is not cost effective for anyone other than large utilities to own transmission.*

Manitoba Hydro to investigate whether the water treatment lift station account is being billed under the appropriate rate and establish a contact for such inquiries. *Manitoba Hydro representatives from the meeting have contacted staff in Rates and Regulatory Affairs on this issue and provided Co-manager's contact information to investigate. Confirmed with INAC that the account should have been changed and the matter has been resolved.*

Manitoba Hydro to contact Lynn Lake District regarding street lights situated where there are no houses and their plans/procedures for relocating these.

Manitoba Hydro to investigate providing the community with maps or other information to assist the community to identify homes referenced by house number on a bill, but which are not actually numbered. *Talked to Customer Service they will be in contact with Chief and Council.*

Manitoba Hydro to follow up with First Nation's Account Manager, or appropriate parties, on whether accounts in good standing are eligible for Equal Payment Plan; and if not discuss the possibility and what barriers may need to be resolved.

Manitoba
Hydro

820 Taylor Ave (4) • Winnipeg Manitoba Canada • R3M 3T1
Telephone / *N° de téléphone* (204) 474-4796 • Fax / *N° de télécopieur* (204) 474-3102
bburdett@hydro.mb.ca

2008 10 17

Chief and Council
Shamattawa First Nation
Box 102
Shamattawa, MB, R0B 1K0

Dear Chief and Council:

OUTSTANDING ISSUES FROM JUNE 26,2008

Included with this letter are draft minutes from our June meeting. I am including responses to the outstanding questions from the minutes as follows:

The contacts for Customer Service are 1-888-MB-Hydro. During regular working hours the system will direct the calls to the appropriate District Office. After hours if you call you can ask to have someone from the District Office return your call the next working day.

Power Smart Program representative for your area is Ed Cook and he can be reached in Thompson @ 1-204-778- 0134.

Billing inquiries are done through Customer Service (above)

Funding requests for community events are handled by Donna Minkus @ 444 St. Mary, R3C 3T7, she can be reached @ # 1-204-480-5230.

The First Nation Accounts Manager is Michel Morin and he can be reached @ 1-204-480-5620.

A portion of Hydro's net export revenues is being allocated by Hydro for the benefit of the diesel-served communities to retire the 'accumulated deficit' by May 1, 2014. The 'accumulated deficit' represents the amount by which costs incurred by Hydro to serve the diesel communities have exceeded the revenues collected through electricity rates in those communities. At March 31, 2004, the amount of the accumulated deficit was $16.9 million. Through the allocation of export revenues, the accumulated deficit has been reduced to a projected amount of approximately $9 million at March 31, 2009.

With respect to your question on how capital costs under the tentative agreement are recovered, I have received the following response:

> "Generally, the Agreement seeks to limit the costs recovered through rates to fuel and operating costs. Capital costs are to be recovered through contributions. The Agreement provides that Manitoba Hydro is to consult with the affected First Nation prior to undertaking any major capital expenditure with the intent that the communities will arrange for contributions to cover the capital costs of the project. Manitoba Hydro is not obliged to commence new projects until contributions have been paid or funding secured. In practice this approach will apply to major capital expenditures - minor ongoing capital expenditures will most typically be recovered in rates. "

We look forward to meeting with the community members of Shamattawa First Nation and presenting our Screening study to them. As discussed we can set this up either in December or sometime in January of 2009.

If there are any more questions feel free to call me any time. I can be reached @ # 1-204-471-3025 or faxed @ # 1-204 474- 3102. We look forward in hearing more of your feedback from the Screening Study presentation.

Yours truly,

Blair Burdett
Aboriginal Liaison Officer

BB/bb/Final response letter to Shamattawa.doc

Manitoba Hydro & Shamattawa First Nations
Meeting Minutes

June 26, 2008

Present: Shamattawa First Nation
Chief Jeffrey Napoakesik
Councilor Howard Canabie
Councilor Ernest Hill
Elder & Community Activist Sam Miles

Aboriginal & Northern Affairs (Province of MB)
Corey Young

Manitoba Hydro
Blair Burdett - Aboriginal Liaison Officer, Aboriginal Relations Division
Brad Johnson - Resource Evaluation, Power Planning Division
Jim Birrell - AMD-North Manager, Apparatus Maintenance Division
Carol Lussier - Administrative Representative, AMD-North

Next Meeting: Yet to be determined.

I. Introductions & Expressions of Thanks

Introductions were completed.

The purpose of the meeting is to provide a presentation to Chief and Council on Alternative Energy Options for the community of Shamattawa and also to address any other concerns which may arise. These high level studies for options of power supply are being shared with the intent of getting people from all sides of the issue talking and gaining input on what direction they wish to pursue. Manitoba Hydro did not provide a recommendation in these studies. Shamattawa First Nation and Indian & Northern Affairs Canada (INAC) must decide on how they wish to proceed and how to provide the required funding for further study.

The Aboriginal Relations Division is involved in this process in acting as Liaison.

Blair Burdett of Manitoba Hydro thanked Chief & Council for welcoming MH staff in the community to allow for an opportunity to share the presentation.

Copies of the following were made available to Chief & Council:

Draft - Generation Resource Screening Study
Handout PPS - Community Power Supply Options

II. Presentation - Community Power Supply Options & Concerns Expressed

1) Energy Efficiency / DSM Programs

Chief and Council asked if Manitoba Hydro would work with the First Nation once again with regards to Energy Efficient Light bulbs. Manitoba Hydro to follow-up by providing contacts for energy efficiency and DSM programs to the communities.

2) 60 vs. 200 Amp

Chief and Council commented that 60 AMP is holding back some potential business opportunities within the community, and thereby economic development. The main issue is with businesses that rely on appliances or equipment with large energy requirements that cannot be met without 200 AMP service. Any power supply options where service remains at 60 AMP face this issue.

3) Transmission Line

Manitoba Hydro staff asked what concerns were brought forward regarding a transmission line when the community previously discussed the potential for alternate power supply options. Chief and Council indicated that the elders didn't want a transmission line; although it seems to be the only option suitable in that it offers limited environmental damage. The main concern raised was the caribou migration. Chief and Council said that the understanding gained from talking with Natural Resources is that the Churchill Transmission Line had little negative effect on the caribou migration over the years, and there are questions as to whether or not the land line may have improved or assisted the migration of the caribou. Manitoba Hydro staff acknowledged that debates on this issue continue today.

Manitoba Hydro staff restated that with the 200 AMP transmission line option, the cost of customers converting to 200 AMP has been excluded.

Manitoba Hydro staff explained that, although a Transmission Line may result in lower rates, there would be an increase of customer bills due to more electricity being available.

Chief and Council asked what the worst case scenario would be for down time with the transmission line and what the response time would be for restoring power. Manitoba Hydro staff responded that a forest fire would be the worst case scenario and could provide for a lengthy outage. Seasons have an effect on response times: outages are less likely in the winter, and lines are more accessible. Depending on the severity of a forest fire, and the difficulty accessing some areas in the summer, the community could encounter a lengthy outage (days). The community should be aware that outages might be more frequent with a land line than with the diesel generating station in the community.

4) Mini / Small Hydro

Chief and Council commented that the Micro Hydro study done by KTC Energy did not explore other potential sites. They could have looked at placing smaller generators in a number of smaller rivers as an option. Manitoba Hydro staff responded that having many generators on different rivers could be a consideration, but that these sites would also have to be identified and studied for adequacy.

5) Wind

Chief and Council inquired about the number of wind turbines that would be installed. Manitoba Hydro staff responded that 4 turbines would be installed initially with up to 7 installed by the end of the study period.

Chief and Council asked if there is currently wind generation in southern Manitoba which supplies a community. Manitoba Hydro staff responded that the energy generated by the wind farm at St. Leon feeds back to the hydro grid, not just to the community.

Chief and council asked for on the level of diesel/wind mix. Manitoba Hydro staff responded that the option studied is a low-penetration option intended to offset a small amount of diesel - up to 20% in this study. Medium-penetration options could offset up to 100% of energy, while high-penetration options could provide more energy than needed. The more wind put in place on a system, the more expensive and complicated it gets to integrate with diesel system.

Chief and Council asked how tall the wind turbines are. Manitoba Hydro staff responded the towers assumed for this study are 50 meters. The turbine blades would extend 25 meters above that.

Chief and Council pointed out that there may be air navigation hazards when the ceiling is below 300-400 feet. Sometimes planes need to land in an emergency in these conditions. Manitoba Hydro staff responded that proper siting would need to be considered in future studies on the option.

Manitoba Hydro staff asked whether or not Manitoba Hydro could access information being collected at the Test Wind Tower, stating that this may require a Band Council Resolution (BCR) from the band. Chief and Council said that this would not be a problem.

6) Ownership / Burden of cost

Chief and Council asked if the First Nation had to come up with the capital dollars involved in choosing an alternate energy option. Manitoba Hydro staff replied that capital does need to be secured, and that INAC would likely fund the majority, where as the Province and Hydro could also possibly see a portion of the costs.

7) Other

Chief and Council expressed that the rate structures was not fair to the First Nations supplied by diesel generation, we are all Manitobans. Diesel communities should benefit from exports as well as the rest of Manitobans on the grid, by receiving the same rates as the rest of the province.

General discussion on the cost of fuel. Chief and Council stated that no one expected oil and gas to escalate to what we are seeing now. This has an effect on the diesel sites - it is an enormous expense.

Chief and Council suggested that the agreement should be revisited and restructured that the higher rate should occur over 3000 kWh as opposed to 2000 kWh. There are some homes with multiple families, so there is higher usage where a number of people are using appliances such as dryers. Manitoba Hydro staff stated that structure is was part of the tentative settlement and was also an issue with the other diesel communities. Chief and Council added that they wouldn't want to re-visit this item again in three to five years. Money spent on bills could be used elsewhere for efficiency.

Chief and Council clarified that they didn't want bad feelings, but felt the need to express these concerns. Chief and Council commented that anything discussed here today does not mean that Manitoba Hydro is not welcome in their community, they feel that Hydro is always welcome but some of these issues have to be brought up. Manitoba Hydro staff responded that is one of the reasons why we are here, we welcome your feedback and your concern for certain issues.

Chief and Council commented that there is room for further negotiations as the rate structure was a tentative agreement. They expressed that Manitoba Keewatinowi Okimakanak (MKO) was not to speak on behalf of the First Nation. Shamattawa wants to be involved, as they do not want to be restricted.

Chief and Council would like to see the 4 diesel sites paying less than the rates established in tentative agreement. Manitoba Hydro spoke to the issue being that due to the location of the diesel sites, and the costs involved to haul diesel in, the rates do not provide for revenues to Hydro. Manitoba Hydro staff stated that export revenue is allocated to the diesel communities. Chief and Council responded that this was the first time hearing that export subsidizes the communities. Manitoba Hydro to follow up with explanation how export revenues are allocated to diesel communities. Explanation: The portion of export revenues allocated to the diesel communities is currently being used to pay down outstanding capital expenditures prior to the new rate structure. The new rate structure does not recover costs from capital projects, so previous expenses still need to be paid.

In reference to 2003 construction (new tank farm), Chief and Council asked how those costs are being recovered. Manitoba Hydro staff indicated that in the past costs were recovered in the rate, but the tentative agreement handles settling outstanding capital expense and how these will be dealt with in the future. Manitoba Hydro to follow up with explanation of how capital costs are recovered under tentative agreement.

The First Nations have had discussions on other options in the past. The major concern raised with solar energy is that there have been times that, due to cloud cover, they did not see the sun for a month. Biomass generation using peat moss as a fuel source had been discussed and concerns were raised as to the effects of using peat moss: there is wildlife that depends on it, and there is potential for other environmental concerns to come up if this was pursued. Small or mini hydro development would not be supported due to the effects observed by the community from existing hydro development in Northern Manitoba. Small nuclear was discussed at a time as well, but there were safety concerns with that. The end result of these past discussions was that the only option to consider as an alternative to continued diesel generation would be a land line.

Chief and Council stated that the two options studied, 60A Wind with Diesel and the Transmission Line, would be the better options.

Chief and Council asked what the cost comparisons are on the options of power supply provided by MH. Manitoba Hydro staff explained the report and went through how the comparisons between options were expressed relative to continued existing diesel. This study was done using the 2006 fuel price forecast and cost estimates, which would have to be updated using current numbers, but the results are expected to be close to the same.

Chief and Council asked that Manitoba Hydro complete a less technical presentation to the community, so the community can have a chance to hear this and decide if they want Chief and Council to enter into negotiations on this. Manitoba Hydro would be willing to provide such a presentation.

Chief and Council expressed that they would like to see a comparison on the costs of heating a home by fuel oil and by electricity. Manitoba Hydro staff pointed to the section of the report that discusses the fuel cost difference between heating with fuel oil and heating with electric heat. This gives an idea of what the cost difference would be.

Chief and Council noted that the presentation in its current form, simply saying that there will be an increase in customer bills, will be seen negatively by the community. Explaining how overall energy costs would change between fuel oil heating and electricity use with 60 AMP, and electric heat and 200AMP electricity use would provide a better picture.

Chief and Council expressed interest in learning how much CO_2 emissions are being generated from burning diesel to heat homes.

Chief and Council commented that CO_2 emissions from Manitoba Hydro's Shamattawa site don't seem enough to raise concerns in Ottawa.

Chief and Council made reference to this study being pushed by INAC and the Province, stating that global warming seems to be the #1 issue. This is an issue that affects people of Shamattawa the same as everyone else - it is important to them too.

8) Items for Follow-up

The next steps will include an opportunity to add more of Chief and Council's feedback on this meeting and could be added to the minutes. These meetings will continue to assist in a decision being moved forward.

Provide a list of contacts to the communities for the following areas:

- customer service
- Power smart/DSM
- billing inquiries
- funding for community events
- First Nations Account Manager

Obtain a BCR from Shamattawa First Nation to obtain the wind monitoring data from CIER.

Manitoba Hydro to follow up with explanation how export revenues are allocated to diesel communities. Explanation: The portion of export revenues allocated to the diesel communities is currently being used to pay down outstanding capital expenditures prior to the new rate structure. The new rate structure does not recover costs from capital projects, so previous expenses still need to be paid.

Explanation: A portion of Hydro's net export revenues is being allocated by Hydro for the benefit of the diesel-served communities to retire the 'accumulated deficit' by May 1, 2014. The 'accumulated deficit' represents the amount by which costs incurred by Hydro to serve the diesel communities have exceeded the revenues collected through electricity rates in those communities. At March 31, 2004, the amount of the accumulated deficit was $16.9 million. Through the allocation of export revenues, the accumulated deficit has been reduced to a projected amount of approximately $9 million at March 31, 2009.

Manitoba Hydro to follow up with explanation of how capital costs are recovered under tentative agreement. *Generally, the Agreement seeks to limit the costs recovered through rates to fuel and operating costs. Capital costs are to be recovered through contributions. The Agreement provides that MH is to consult with the affected First Nation prior to undertaking any major capital expenditure with the intent that the communities will arrange for contributions to cover the capital costs of the project. MH is not obliged to commence new projects until contributions have been paid or funding secured. In practice this approach will apply to major capital expenditures - minor ongoing capital expenditures will most typically be recovered in rates.*

Meeting adjourned at 3:30 p.m.

Johnson, Brad

From: Corfield, Tannis on behalf of Kristjanson, Ruth
Sent: Friday, June 06, 2008 3:27 PM
To: 'David Hallman'
Cc: 'Rothney, Anna (CTT)'; Orr, Rhonda
Subject: Diesel Communities

Attachments: INAC Correspondence.pdf

Hello David,

Anna indicated you may be able to assist us in determining who we might approach in INAC regarding upcoming discussions with the four Manitoba communities that use diesel generated power. As you may be aware, we have resource screening studies we would like to discuss with them and INAC.

I have sent previous documentation (attached) to Blair Carlson but I just recently learned he is no longer there which may explain, in part, why I have yet to receive any replies.

It would be greatly appreciated if you could advise us as to who we can deal with in INAC. I understand Don Cook has replaced Blair but I am not sure that he is the right person to engage.

Thank you for your assistance.

INAC
espondence.pdf (14

~~~~~~~~~
Ruth

E. Ruth Kristjanson, Vice President
Corporate Relations
Manitoba Hydro
820 Taylor Avenue
Winnipeg, MB R3C 2P4
Telephone - 204-474-4671
Fax - 204-474-4114
erkristjanson@hydro.mb.ca
~~~~~~~~~

Manitoba
Hydro

from the Office of the Vice-President

2008 03 07

Mr. Blair Carlson
Acting Regional Director General
Indian and Northern Affairs Canada
200-365 Hargrave Street
Winnipeg, MB R3B 3A3

Dear Mr. Carlson:

Attached please find draft Generation Resource Screening studies for the four remaining diesel serviced communities in Manitoba.

This information has been provided to the community leadership and is being provided to you with the understanding that the report is draft and we would like to hear your comments. It should be noted that the level of detail and accuracy is not to the degree required for a decision but rather provides an indication of the relative economics of potential future supply options.

As per the tri-party agreement with INAC, the First Nations of Brochet, Lac Brochet, Tadoule Lake and Shamattawa, Manitoba Hydro will be looking to discuss with our customers, the First Nations, the future supply needs of the communities as well as funding requirements for those future supply needs prior to entering into more detailed engineering studies.

We have offered to make ourselves available to discuss the reports with the First Nations, however, no meeting have been scheduled yet. We would also welcome INACs participation in these meetings and will let you know when they are arranged.

Yours truly,

ER Kristjanson

E. Ruth Kristjanson
Vice-President
Corporate Relations

ERK/tmc

Attachments

820 Taylor Avenue Winnipeg, Manitoba CANADA R3M 3T1 erkristjanson@hydro.mb.ca
Telephone / *N° de téléphone* : (204) 474-4671 Fax / *N° de télécopieur* : (204) 474-4114

Manitoba
Hydro

from the Office of the Vice-President

2008 05 01

Mr. Blair Carlson
Acting Regional Director General
Indian and Northern Affairs Canada
200-365 Hargrave Street
Winnipeg, Manitoba Hydro R3B 3A3

Dear Mr. Carlson:

Further to my previous letter of March 7, 2008, we are beginning to arrange meetings with the communities to discuss the Generation Resource Study Reports and it would be beneficial for INAC to be involved in those discussions. Could you please provide the name of your staff that we should be involving in this issue? My staff will be in contact shortly after receiving the information as our intention is to schedule the meetings for late spring or early summer.

Yours truly,

ERKristjanson

E.R. Kristjanson
Vice- President
Corporate Relations

ERK/tmc

820 Taylor Ave (3)-ExecOffices • Winnipeg, Manitoba • CANADA R3M 3T1 • erkristjanson@hydro.mb.ca
Telephone / *N° de téléphone* : (204) 474-4671 • Fax / *N° de télécopieur* : (204) 474-4114

Manitoba
Hydro

from the Office of the Vice-President

2008 05 26

Mr. Blair Carlson
Acting Regional Director General
Indian and Northern Affairs Canada
200-365 Hargrave Street
Winnipeg, Manitoba
R3B 3A3

Dear Mr. Carlson:

Manitoba Hydro staff have scheduled meetings with each of the four diesel communities to discuss the Generation Resource Screening Reports as follows:

Brochet
Barren Lands Chief and Council and Brochet Mayor and Council
June 23, 2008 - 10:00 am.

Lac Brochet
Northlands First Nation
June 24, 2008 - 10:00 am

Tadoule Lake
Sayisi Dene First Nation
June 25, 2008 - 10:00 am

Shamattawa
Shamattawa First Nation
June 26, 2008 - 10:00 am

820 Taylor Ave (3)-ExecOffices • Winnipeg, Manitoba • CANADA R3M 3T1 • erkristjanson@hydro.mb.ca
Telephone / *N° de téléphone* : (204) 474-4671 • Fax / *N° de télécopieur* : (204) 474-4114

Although our staff have been in discussions with both Ken Einarsson and Tebesi Mosala of INAC regarding participation in these meetings, I have not received correspondence indicating the lead staff member on this issue. As you can understand, we feel that this is an important piece of work and we want to ensure that the appropriate staff from INAC are informed and involved.

I look forward to your confirmation of your staff's participation in these meetings.

Yours truly,

ER Kristjanson

E.R. Kristjanson
Vice- President
Corporate Relations

ERK/tmc

Alternative Energy
Meeting Minutes
October 23, 2008
INAC Offices
365 Hargrave Street
Winnipeg

Attendees - INAC

Aaron
Ron Payne
Daniel Charbonneau
Tebesi Mosala
Emmanuel Atiomo

Regrets - INAC

Anna Fontaine
Daniel VanVilet
Ken Einarsson
Amy Keuhl

Attendees - Manitoba Hydro

Rhonda Orr
Ruth Kristjanson
Jim Birrell
Brad Johnson
Rob Cox
Blair Burdett

Manitoba Hydro delivered a presentation on Generation Screening Studies for Tadoule Lake, Shamattawa, Brochet and Lac Brochet. A copy of the presentation is attached.

Manitoba Hydro indicated that the reports were not intended to provide detailed information for final decision making, but rather to give general indication of the economic feasibility of potential generation options and highlight other issues associated with each potential option.

Concerns were raised regarding detailed environmental issues like migration paths and shoreline erosion. Manitoba Hydro indicated that the reports were high level and that those issues would be looked at in the next phase of any studies.

The potential for kinetic turbines was raised. Manitoba Hydro is currently undertaking a research and development project with the University of Manitoba to determine potential and issues with kinetic turbines in our climate. The results of these studies are not yet available. It was also indicated that it was unlikely that kinetic turbines could replace the diesel generators, however they may offset some fuel consumption.

Manitoba Hydro indicated that the information was provided to INAC and the communities as customers of Manitoba Hydro. The next step and decision on whether or not to pursue other generation was that of the customer and not Manitoba Hydro. As per the tentative settlement agreement, all significant capital costs are to be agreed to and funding in place prior to proceeding.

INAC indicated that from an economic perspective that continued diesel operation appeared to be the best alternative. Manitoba Hydro indicated that with the assumptions for economic parameters used in the report that continued diesel operation was the least cost approach.

Biodiesel Price Forecast

The current market price of biodiesel is tracked by various consultants, however, there are few long term price forecasts available. The US DOE Energy Information Agency does produce an unpublished forecast. Economic Analysis requested that unpublished information but was informed by the EIA that it would not be released to non-Americans.

A price forecast may be contained in a consultant's report on the biodiesel market entitled "Biodiesel 2020: Global Market Survey, Feedstock trends and Forecasts". This is a 685 page 2008 (2nd edition) multiclient study done by Emerging Markets Online, and is priced at USD $2950.

In 2008, the OECD published the "OECD-FAO Agricultural Outlook 2008-2017". This outlook does contain a forecast of crude oil, agricultural oilseeds, and biodiesel prices. The forecast of Brent crude and biodiesel prices are shown in the following table in nominal USD per barrel and nominal USD per hectolitre.

	Crude (USD/bbl)	(USD/hl)	Biodiesel (USD/hl)
2008	90.00	56.60	98.60
2010	90.00	56.60	105.80
2012	92.80	58.36	104.20
2015	100.10	62.96	106.30
2017	104.00	65.41	105.50

Note: one US barrel contains 159 litres, one hectolitre is 100 litres.

A proxy for the market price of petroleum diesel fuel could be indicated by adding the usual refining margin of $5 - $10/barrel (or $3 - $6/hl) to the price of crude oil to obtain a diesel fuel price estimate. The refining margin is a range estimated by Deutsche Bank analysis. Even so the OECD expects the price of petroleum based diesel fuel to be roughly half the price of oilseed/yellow grease based biodiesel. Financial pressures have put much of the world into a situation of recession or no growth for 2009. As a result crude oil prices have come down substantially and in early 2009 were in the USD $40 - $50 range, approximatley half the OECD forecast value for 2008. This is significant because crude oil is the refining stock for normal diesel fuel and while a reduction in crude prices will result in lower refined product prices the effect on biodiesel feedstock prices is likely to be minimal. Note that the feedstock cost can be up to 90 % of the cost of making biodiesel fuel.

Status of Manitoba/Manitoba Hydro Biodiesel Pilot Project

Current Status:

As of February 2009, three of the four tanks of B5 biodiesel had been successfully burned during some extreme weather conditions in the diesel generators at Manitoba Hydro's facilities in Brochet, Manitoba. The biodiesel in the remaining tank continues to be monitored for potential degradation for a further nine to twelve months.

Background:

In February, 2008 six tanker truck loads, a total of 173,000 litres, of B5 blended biodiesel was delivered to the diesel generating station in Brochet, Manitoba and stored in four separate tanks. Storage of the biodiesel was kept separate from diesel so that the product could be monitored during storage and consumption.

As there was no biodiesel available from within Manitoba, the biodiesel for this pilot project was purchased from an established biodiesel plant in Ralston, Iowa. It was made from soybean feedstock. The intention for future use is to purchase Manitoba produced canola based biodiesel. Soybean biodiesel does not perform as well for cold weather properties as canola based biodiesel

Cold Weather Properties:

The key test for cold weather properties is the Cloud Point test. Prior to shipping the product to the generating facility, cloud point tests were conducted by the Manitoba Hydro lab at Selkirk on the diesel, the biodiesel and the B5 blend. The blended cloud point was determined to be -37°C. This was marginally acceptable for Brochet use. Original plans had been to also test B10 as part of the pilot, but based on the results of the cloud point testing, it was decided to limit the pilot test to use of B5.

Canola based biodiesel has better cold weather properties than soybean based biodiesel. It is anticipated that a higher blend of biodiesel may be used with canola based biodiesel, however further testing will be required. Other additives are being explored as a way to potentially lower the cloud point of the biodiesel which in turn may facilitate the use of higher blends in these extreme climatic conditions.

Fuel Stability:

As the fuel in the diesel serviced communities needs to be stored for long periods of time without degradation, tests were completed to determine the stability of the biodiesel. Oxidation stability and Acid Point tests have been completed at various times on the stored biodiesel. The results have been satisfactory and the product appears to be holding well. As of late February, 2009 no issues have been discovered.

Future Project Milestones:

Plans are to complete the testing of the B5 fuel in storage to ensure fuel stability and evaluate the feasibility of using B5 in all four remote communities. Maintaining acceptable cloud points as well as potential significant price differentials between biodiesel and diesel are issues that may need to be dealt with.

Should the results of this project be successful with the implementation of B5, further testing will be carried out to try to achieve a maximum safe blend in order to achieve the most emissions reduction without jeopardizing the safety and reliability of service to these communities.